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J11510-001

Varlamov AA

JUDGMENT ON THE DEVELOPMENT OF TECHNOLOGIES

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Introduction. Modern technologies are the product of material activities and thus develop under the laws of the material sphere. Consequently, the general laws of matter can be applied to the study of material behavior in time and to consider changes in technology that affect the material object. One of the basic laws in the material world around us is the law of conservation of energy. This law postulates that the energy of an isolated system, with all processes in the system is maintained. In relativistic mechanics, the law of conservation of the total (including the rest energy) energy. Energy - this is a common quantitative measure of various forms of motion. To quantify qualitatively different forms of motion is accepted to distinguish types of energy: mechanical, gravitational, electromagnetic, nuclear, thermal, etc.

Including in the social forms of energy and other. You can assume the influence of the laws of motion of time and energy on the physical processes taking place in the development of society, including the development of technology. Below are statements about the development of energy and related time with respect to the interaction of a material object with external influences and, in part, to the interaction of man and external destructive effects (life expectancy). The extension of these judgments on the development of technologies will allow to evaluate the correctness or falsity admitted reasoning. Accept or deny the following proposition offered to the reader.

1. General assumptions about the connection object technology and time.

To assess the behavior of the material system is necessary to consider the process in time. The object of the study represented a collection of smaller objects, particles bound in a single system. The binding energy of the system is equal to the difference between the total energy of small objects (particles) in a free state (ie, when the particles do not interact) and the energy of this coupled system of the same objects (particles).

Make some assumptions. For this we consider the interaction of two systems: the object and the external force, destroying the object to its constituent objects particles. And the external energy \mathbf{A} is aimed at the destruction of the binding energy of the particle \mathbf{U} object. Binding energy as a whole represents a collection of different types of energy are treated as a single distributed energy in time. It is possible, of course, consider the sum of the individual constituents and binding energy, but individually measure them and their interconversion practically impossible. We write the condition of the destruction of the binding energy of the object in time: $d\mathbf{A}/dt \geq d\mathbf{U}/dt$. At each time press the external energy (power) must exceed the internal binding energy (power) of the object. Now suppose that there is a graph of the distribution power of the object over time. Consider this graph in Fig..1 on the axes "acceleration energy - time" - « $\mathbf{B-t}$ ». On the vertical axis of the graph under consideration - the acceleration in energy, $\mathbf{B},^1 \text{ Дж}/c^2$; the horizontal axis - time t . Acceleration energy \mathbf{B} in note how some notional value is determined by the change

in power per unit time necessary for further constructions. At time t_o (the beginning of the interaction energy, causing the destruction of the object) material system is characterized by a set of macro parameters Q_1 and the binding energy of U_1 . At time t_L (interaction energies end - taking as the point of destruction of the sample, for example, corresponding to the maximum load of the object) obtained after the destruction of the material (object-particle) is characterized by a set of energy and Q_2 macroparameters U_2 . The value of $U = U_1 - U_2$ determines the binding energy.

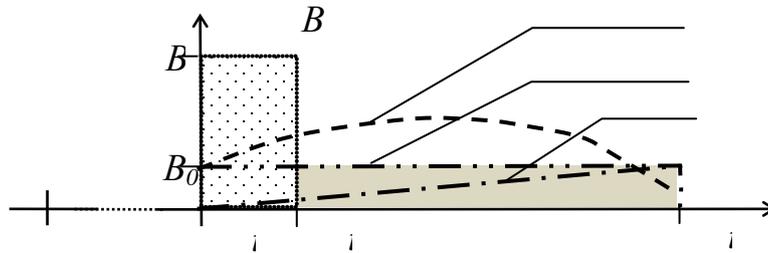


Fig.1. Power distribution facilities in time

Some possible power distribution of the binding energy U marked in Fig. 1 positions 1,2,3. The shape of the power of external action, we can ask. If you take the form of the power of external influence on the media studied object in the form of a rectangle $B^* t_x$, the condition of the destruction of the binding energy of the sample at any given time can be written

$$B^* \cdot t_x > \int_{t_x}^{t_L} B(t) dt. \tag{1}$$

The value $B^* = \frac{\int_{t_x}^{t_L} B(t) dt}{t_x}$ will be given the acceleration of the binding energy of

sample object at the current time t_x . The obtained value of B^* predicts the behavior of the binding energy of the sample over time. In the future, the value of B^* is called "potential energy" so that it corresponds to its essence and behavior - always decreases with time. The value of $B^* dt$ is the elementary power of resistance of the binding energy of the sample. Then the distribution of its own power of the test sample in time from the onset of exposure t_a to the current time t_x is written:

$$P(t) = \int_{t_a}^{t_x} \frac{\int_{t_x}^{t_L} B(t) dt}{t_x} dt. \tag{2}$$

Depending (2) is considered the time interval from 0 to t_L , provided $t_o = 0 < t_a <$

$t_x < t_L$. t_a value appears due to the inability to take the value 0. In this case, the graph $P(t)$ is always positive, and t_x tends to t_a power tends to 0. However, this raises the question, what value should be taken t_a .

In this case, the onset of action is invited t_a as a value determined from the dependence of $t_a = P_{el} / B_m$, where P_{el} - the current value of the elastic power, and B_m - modulus of elasticity of the material (in this case) in the axes « $P - t$ ». Then the line $P = Bt$ in the plane $P - t$ separates the working area of the object (such as material, human society) without aging from the area of aging and destruction (for material - plastic deformation). The derivative of this line on the plane " $B-t$ " is a horizontal line, which shows that the traffic on this line causes no change in the "capacity" of the object in time, and it is not destroyed. If we assume the existence of the elastic region (zone operation without aging), then it is possible to describe the shape and other additions (not just linear).

Some of the simplest options for power distribution facility in time $P(t)$, shown in fig. 2. Figure 2 conventionally denoted t_L as L , and is referred to as $t_x - x, t_0 = 0$, shows the relation describing the potentials distributed according to schedule.

The overall analysis of the data presented in the figure shows:

1. These terms have function, consisting of two (or more in other forms of power distribution in time) independent factors one of which is time dependent on the energy of the other.
2. The above acceleration energy (potentials) can be added.
3. The graphs above acceleration energy are close to each other form (hyperbole). This means that the behavior of objects with different shape of the energy distribution will be similar in general.

When rectangular orthographic drawing acceleration energy of the object

$$B^*(x - t_0) > B_0(L - t_0 - x) \text{ or } B^*(x) > B_0(L - x). \tag{3}$$

In case of equal value B^* characterizes material object at a certain time and is its own potential energy in the acceleration time.

Then we can write:

$$B^* = B_0 \left(\frac{L - 2t_0}{x - t_0} - 1 \right) \text{ or } t_0 = 0: B^* = B_0 \left(\frac{L}{x} - 1 \right). \tag{4}$$

It should be noted that:

1. Formula (1 ... 4 and fig. 2) obtained with rectangular orthographic external influences. External energy distribution of acceleration in the general case and may have any other shape. In another form of the distribution of the acceleration of the external energy at certain times external impact may be less than the internal resistance. In this case, we shall test and determine for themselves the form of

external influence.

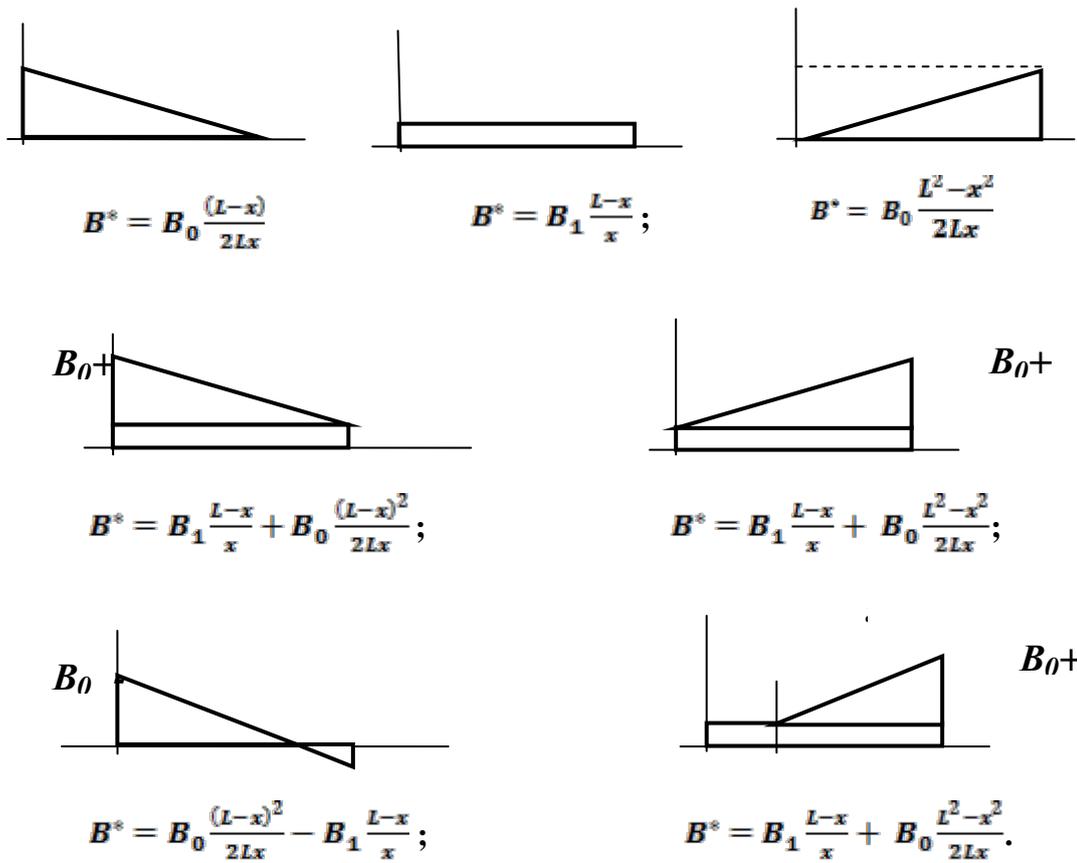


Fig.2. Graphics power distribution of the sample and the corresponding expressions for the determination of the potential

2. These basic dependence allow us to estimate the effect of time and start living facility t_0 in potential energy. Usually L is much smaller than t_0 , so it's easier to take the reference null point $t_0 = 0$, then the life expectancy is equal to L .

3. If the acceleration is less than the external energy self-accelerating energy of the object, in this case we get a "timeless" system, independent of the time (but dependent on external forces, energies).

4. On the basis of illustrated, for the effect of time on the energy necessary to overcome at least two barriers: B_0 and total capacity of the facility.

Consider the simplest dependence (4). To simplify the analysis in constructing graphs assume relative coordinates: $B_0 = 1$, $L = 1$, and $t_0 = 0$, then the function (4) takes the form $B_1^* = (1/x)-1$. Figure 3 shows a graph of the resulting function - line 1. The figure also shows a rising function graphs $B_2^* = x / (1-x)$ - (increase potential energy of the object) - Line 2; lines and graphics comparison, line 3 - the graph of $B_3^* = 1/x$, the line 4 - the graph of $B_4^* = x$. All these lines in comparison to some extent characterized by the distribution of potential energy and capacity over time. Additionally, the figure shows the graph of the potential energy distribution pos.3 in Figure 1 and Fig. 2d - for linearly rising function of acceleration energy: $B_5^* = 1/2(1/x -x)$ - Line 5, and linear functions descending from Fig. 2a: $B_6^* = 1/2(1/x -2 + x)$ - line 6. In sum, the last two functions allow the distribution function

$$B_1^* = B_5^* + B_6^* = 1/2(1/x -x) + 1/2(1/x -2 + x) = (1/x)-1.$$

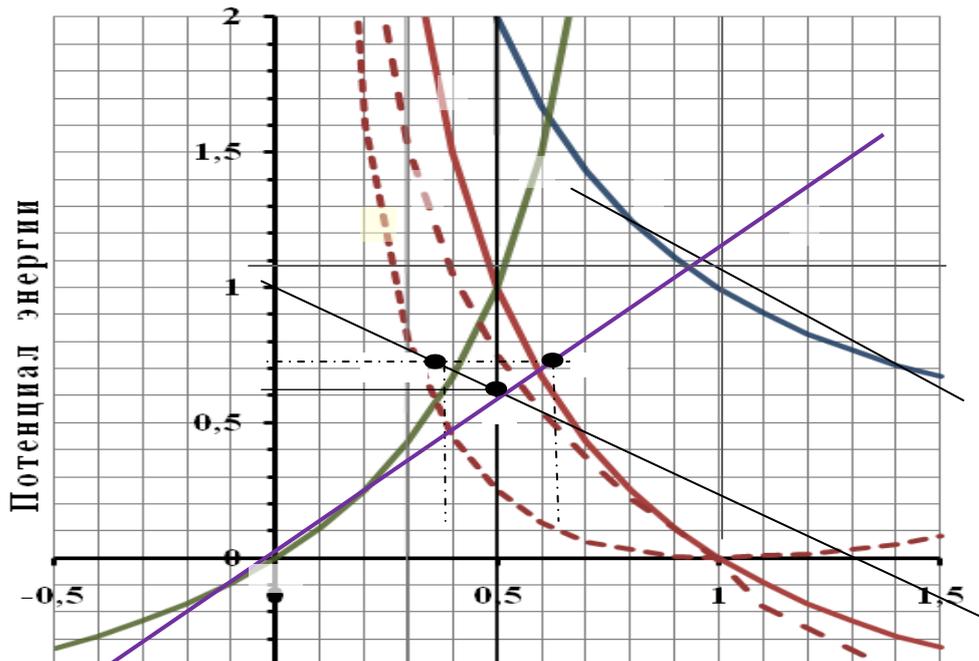


Fig 3. Dependence of the relative energy potential in coordinates relative time

According to the first graph (line 1), the potential energy of the object occurs abruptly (the transition from one property to another) and for the first time point (A) to quantify the potential of an object is almost impossible to estimate. Then the value of this potential decreases sharply and then is smoothly damped. Character of change of potential energy schedules uplink and downlink linear acceleration energy (lanes 5 and 6) has a potential similar to a rectangular shape. Unlike these graphs to the end of "lifetime" of the object is mainly in the magnitude values of the potential energy. After the end of "lifetime" line 5 goes into the negative region, and line 6 remains positive.

Uplink accumulation shows a second graph (lanes 2). On the first steps of life accumulation is slow, and before the end of the term "life" is the accumulation of potential avalanche. Accumulation potential can be interpreted as the accumulation of defects and the accumulation of information.

Charts 1 and 2 cross the x -axis (time) at an angle of 45° , that enables us to determine the beginning and end of "life." The beginning of "life" (point A) mined moment in which the growth potential exceeds the growth time, the end of life (A + L) - when the increase in external potential energy ogy so reduce its own potential energy of the object that it from application of starts keep up with the growth time. The point of intersection of the curve 3 and curve 4 is the bisector of the angle x - y is a point of symmetry of the curve 3. The figure marked by three specific points: the first point c with coordinates $(x = 0.5, y = 1)$, corresponding to the equilibrium lines of "life" and the line "knowledge"; second point $c1$ $(x = 0.382, y = 0.618)$, which lies at the intersection of the bisector of the axes with the line "life"; third point $c2$ $(x = 0.618, y = 0.618)$ symmetric $c1$. Point $c1$ and $c2$ - characterize the so-called "golden

section", defined by the equation $\frac{1}{x} = \frac{x}{1-x}$. It can be shown that the coordinates corresponding to the values of "golden section" are saved in the construction of graphs in absolute coordinates.

Take the value of the potential energy B^* in the corresponding we need a fixed value of time x_1 (for example, B^*_1 depending on the (4) for age $x_1 = 1s$ and life expectancy $L = 100$ years is $30,5 \cdot 10^8$) we write the expression for L in the form of:

$$L = x \left(\frac{B_1^*}{B_0} + 1 \right) \tag{5}$$

From the above expression shows that the greater the intensity of the flow of vital force, the shorter the duration of life.

2. *Behavior of potential energy and power objects in time.*

Consider the relationship (1) when $B = 1$ and the origin $A = 0$. Curve energy potential relative coordinates $x = nL$ - the base curve is the same for all values of L . The graph has an integral depending greatest ordinate at the point $x = L$ and $y = 1$ (since $B = 1$ or $y = B$, when B is unity). Product $P = BL$ is a value that characterizes the full potential of energy properties of the lifetime and may be characteristic properties of the material. Since the value of P can be realized at different times of life, while retaining its value, we obtain $B = P / L$, and B - is the quantity characterizing the potential of the material then the formula 5 can be rewritten as

$$y = \frac{P}{x-A} - \frac{P}{L} \tag{6}$$

From the relation (6) we see that when the lifetime (tests - artificial lifetime appointment) changes only the second term dependence. Changing the properties of an object depending on the duration of the test takes place in a hyperbolic dependence. For example, for a value of $x = 0,5L$ and $A = 1 - y = P / L$ reduction in the lifetime of the object at a constant value W increases the value of the potential energy of the object properties. This is what we observed in test objects with increasing loading rate - increases strength.

Figure 4 shows a graph showing the change in the power of the object over time or implementation capacity over time (area under the curve 1 in Figure 1). Schedule was built in axes "power - time" - " $P-t$ ". If you work with at constant velocity s/t then we can write the power as $P = Fs/t$ (force x distance and divided by time) and go to the other coordinates: $Fs/t : s/t$ - $t \times s/t$ or $F- s$ «force - displacement". Consequently, spent "standard tests" at a constant speed can be obtained potential impact energy of the object and then use it in the calculation of the time behavior of an object.

Leaving formulas for simplicity and some indices, taking the form of distribution according to fig.2b, we obtain the expression changes of the total capacity of the facility in time ($t_0=0$):

$$P = \int_a^x B_1 \left(\frac{L}{x-t_0} - 1 \right) = B_1(L \ln x - x - L \ln a + a) = B_1 L \left(\ln \frac{x}{a} - \frac{x-a}{L} \right) \tag{7}$$

In the expression (7) corresponds *to* the value of Figure 1, but the here and

further analysis is not considered: $t_0 = 0$. The expressions obtained show the change in the total power of the object over time, starting from the time a . A plot of (7) is shown in Figure 4. Since the numerical value of the initial state of the object (a) is not defined, then the initial point in Fig. 5 takes the value 1s relative to 100 years, has turned a relative value equal to $x=a=3,17 \cdot 10^{-10}$.

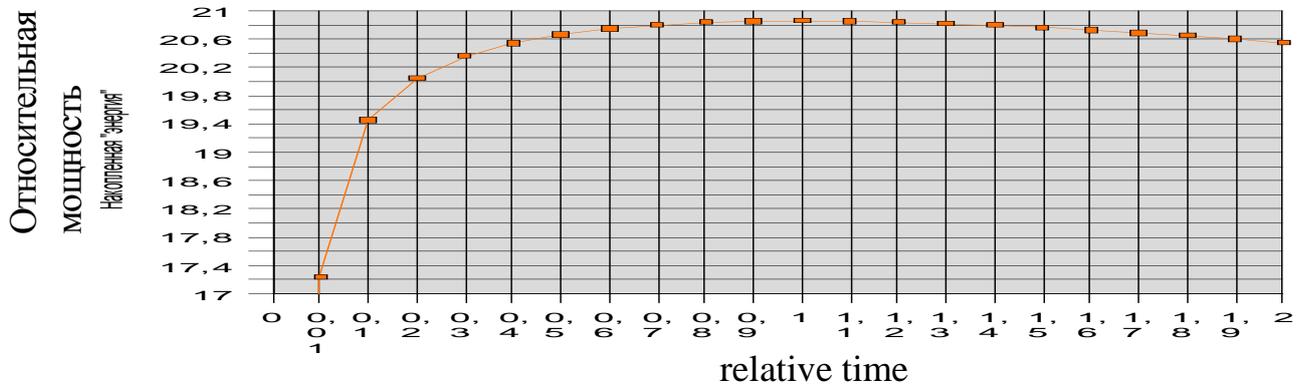


Fig.4. Changing the power of the object over time

From the graph in fig. 4 shows that over 92% of capacity consumed in the first 10% of the life of the facility. Moreover, after the "death" of the object is reduced capacity significantly slower than accumulated during his life. Figure 5 shows the graphs of the material behavior in the axes "Power-time." The horizontal axis is shown in logarithmic coordinates. Graphs different duration of the test. The first graph - 2 minute duration of the test, the second - 20 minutes, the third - 200 minutes. The graphs show an increase in strength of the material with fast uploading and reducing the strength of the long-term tests.

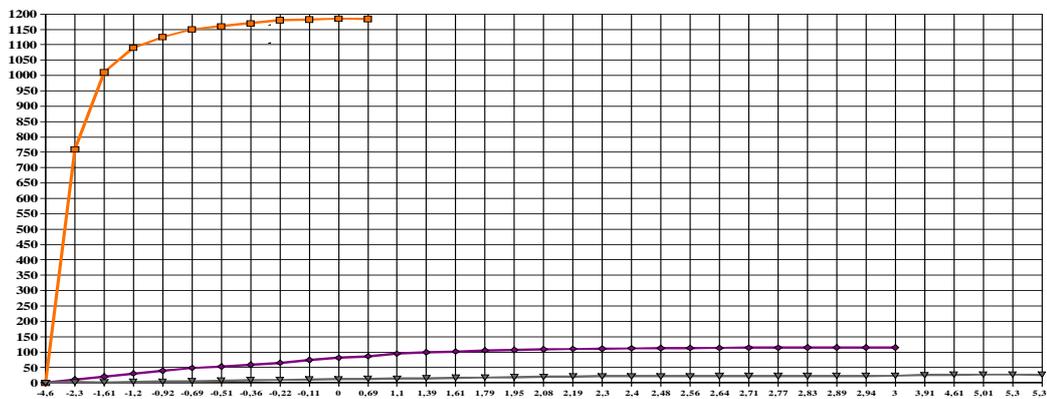


Fig.5 . Changing strength test of concrete prisms

Transform the obtained dependence (8) for the case of constant speed displacement in time. Примем скорость v равной

$$v = \frac{l_{max}}{L}, \text{ тогда } a = \frac{l_a}{v} = \frac{l_a L}{l_{max}}; x = \frac{l_x}{v} = \frac{l_x L}{l_{max}}; P = Fv. \text{ Rewrite the equation (7)}$$

$$Fv = F \frac{l_{max}}{L} = B_0 \frac{l_a L}{l_{max}} \left[\frac{l_{max}}{l_a} \ln \frac{l_x}{l_a} - \frac{l_x}{l_a} + 1 \right].$$

Consider the test object prismatic section axb and height h . We define an external force through elastic deformation $F = E\varepsilon_{el}ab$ and displacement in terms of relative deformation $l_{max} = \varepsilon_{max}h$; $l_a = \varepsilon_a h$; $l_x = \varepsilon_x h$. Given that the expression in square brackets is set to zero when conditions are $l_x = l_a$. Determined l_a by the elastic deformation - absolutely elastic deformations do not cause aging and destruction of the sample, ie, accept $l_a = l_{el} = \varepsilon_{el}h$. Plastic deformation and aging cause the destruction of the material and place in excess of the overall deformation of elastic deformations. Based on the above, we can write:

$$E\varepsilon_{el}ab \frac{\varepsilon_{max}h}{L} = B_1 \frac{\varepsilon_{el}L}{\varepsilon_{max}} \left[\frac{\varepsilon_{max}}{\varepsilon_{el}} \ln \frac{\varepsilon_x}{\varepsilon_{el}} - \frac{\varepsilon_x}{\varepsilon_{el}} + 1 \right].$$

Given that $abh = V$ determines the amount of test sample:

$$\frac{\varepsilon_{max}}{\varepsilon_{el}} \ln \frac{\varepsilon_x}{\varepsilon_{el}} - \frac{\varepsilon_x}{\varepsilon_{el}} + 1 = \frac{EV\varepsilon_{max}^2}{B_1L^2} \tag{8}$$

For a point of maximum values of elastic $\varepsilon_{el,max}$ total deformation reaches a value ε_R , then the last expression for a given case can be written:

$$\frac{\varepsilon_R}{\varepsilon_{el,max}} \ln \frac{\varepsilon_R}{\varepsilon_{el,max}} - \frac{\varepsilon_R}{\varepsilon_{el,max}} + 1 = \frac{EV\varepsilon_R^2}{B_1L^2} \tag{9}$$

Knowing the values E, V, ε_R, L and specifying the value of elastic deformations

on the dependence of (8.9) we plot the behavior of the material. By varying the duration of the test $L(t_L)$ obtain strains change over time. It should be borne in mind that the value B_1L remains constant.

From (8) and (9) to obtain a constant value of L :

$$\frac{\varepsilon_R}{\varepsilon_{el}} \ln \frac{\varepsilon_x}{\varepsilon_{el}} - \frac{\varepsilon_x}{\varepsilon_{el}} = \left(\frac{\varepsilon_R}{\varepsilon_{el,max}} \ln \frac{\varepsilon_R}{\varepsilon_{el,max}} - \frac{\varepsilon_R}{\varepsilon_{el,max}} \right),$$

a constant growth rate of stress $v = \frac{l_{el,max}}{L}$ (9) and (8) we have:

$$\frac{\varepsilon_{el,max}}{\varepsilon_{el}} \ln \frac{\varepsilon_x}{\varepsilon_{el}} - \frac{\varepsilon_x}{\varepsilon_{el}} = \left(\ln \frac{\varepsilon_R}{\varepsilon_{el,max}} - \frac{\varepsilon_R}{\varepsilon_{el,max}} \right).$$

Suppose that the function describing the distribution of energy in the acceleration time is continuous on the selected time interval and can be approximately described by the Taylor formula. Taylor's formula we take as a polynomial: $B = b_0 + b_1x + b_2x^2 + b_3x^3 + b_4x^4 + b_5x^5 + \dots$ (10)

The coefficients b_i in this formula depend on the value of the argument to the point where we describe the function and the derivatives of the function at that point.

We write down the value of the potential in accordance with the form of the distribution of acceleration in relative units (11):

$$t_L=1; 0 < t_x = x \leq 1: \\ B^* = \frac{b_0}{1} \left(\frac{1}{x} - 1\right) + \frac{b_1}{2} \left(\frac{1}{x} - x\right) + \frac{b_2}{3} \left(\frac{1}{x} - x^2\right) + \frac{b_3}{4} \left(\frac{1}{x} - x^3\right) + \dots$$

Figure 6 shows the graphs of the series:

$$y = -1; -x; -x^2; -x^3 \dots -x^{10}; -x^{20}, \text{ при } 0 < x \leq 1.$$

It can be seen that an increase in the exponent of the curve charts are pressed against the coordinate axes, the impact of a number of members with higher degrees of decreases. Consequently, the resulting series is convergent.

Further, in Figure 10 shows the graph of a function of a number: $\left(\frac{1}{x} - 1\right); \frac{1}{2}\left(\frac{1}{x} - x\right); \frac{1}{3}\left(\frac{1}{x} - x^2\right); \frac{1}{4}\left(\frac{1}{x} - x^3\right); \dots \frac{1}{11}\left(\frac{1}{x} - x^{10}\right); \frac{1}{21}\left(\frac{1}{x} - x^{20}\right)$.

Potential B^* is obtained by summing the curves obtained from such a series with the coefficients b_i .

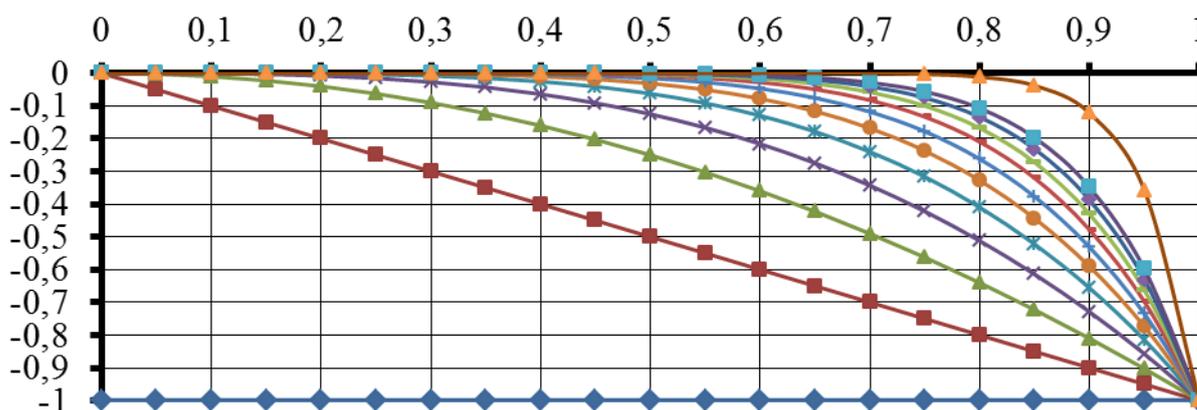


Fig..6. The functions of a number:
 $y = -1; -x; -x^2; -x^3 \dots -x^{10}; -x^{20}.$

Considering the curves shown in fig. 7 it is clear that a number that describes the potential of B^* convergent. The resulting curves have a similar shape.

The curvature of the graph is gradually reduced. At subsequent lines chart buckling occurs with changing curvature.

At subsequent lines chart buckling occurs with changing curvature. The largest deviation from the curvature of the fade (buckling) for plotting the vertical of 0,025 for graphics with x^9 (in the figure below held control line showing the change in curvature graphs).

Summation curves based on b_i coefficients will produce curves similar to those shown on the graph with possibly wavy sea. The tangent to the curve can't have a negative slope, or perhaps total intersection curve with the x-axis, which would mean the transfer point t_L .

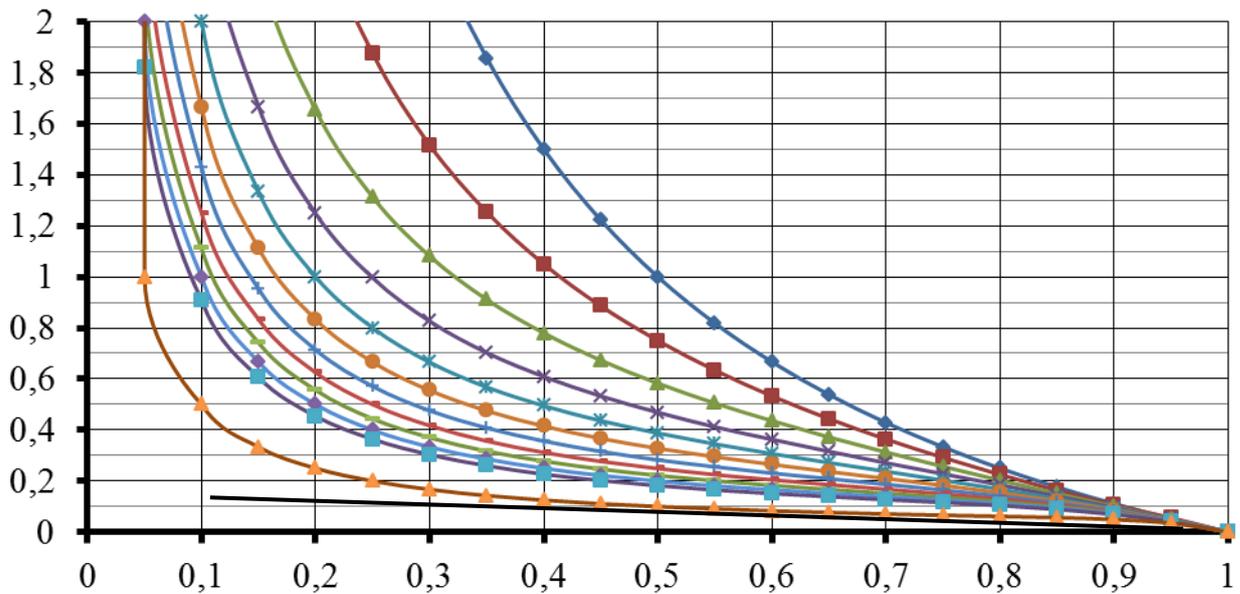


Fig.7. The functions of a number:

$$\left(\frac{1}{x} - 1\right); \frac{1}{2}\left(\frac{1}{x} - x\right); \frac{1}{3}\left(\frac{1}{x} - x^2\right); \frac{1}{4}\left(\frac{1}{x} - x^3\right); \dots; \frac{1}{11}\left(\frac{1}{x} - x^{10}\right); \frac{1}{21}\left(\frac{1}{x} - x^{20}\right).$$

The main conclusions of the analysis functions:

1. Potentials most functions have similar shape, ie the behavior of the potential energy in time for many objects alike.
2. There are waves on the line capacity, slowing down or speeding reduce it. Waves on the change in potential energy can be called as a function of the kind of acceleration energy and process approach.
3. The potential function (without external influence) continuously decreases with time (his property).
4. The growth potential of the object in time is only possible due to the influence of external energy.

The diagram "*P-t*" modulus is given by $P_{el}/t_{el} = E_{el}$, respectively, in the chart-building - sloping line turns into a horizontal coordinate with $B = E_{el}$, which means that the elastic modulus is an energy characteristic of the object.

In the case of rectangular diagrams acceleration energies express the value of life expectancy as $L = \gamma x \geq x$ (γ - const, is greater than one), then the connection of the elastic modulus with the acceleration energy can be written as

$$B^* = B_1 \frac{L-x}{x} = B_1 \frac{\gamma x - x}{x} = B_1 (\gamma - 1) = E_{el} \tag{12}$$

The case when the potential energy is constant, it is possible, if

$$\begin{aligned} \tan \alpha &= \frac{d(B^*)}{dt} = 0 = \frac{d\left(\int_{t_x}^{t_L} B(t) dt / t_x\right)}{dt} = \\ &= \frac{d\left(\frac{b_0}{1}\left(\frac{1}{x} - 1\right) + \frac{b_1}{2}\left(\frac{1}{x} - x\right) + \frac{b_2}{3}\left(\frac{1}{x} - x^2\right) + \frac{b_3}{4}\left(\frac{1}{x} - x^3\right) + \dots\right)}{dt} = \\ &= -\left[\left(\frac{b_0}{1} + \frac{b_1}{2} + \frac{b_2}{3} + \frac{b_3}{4} + \dots\right) \frac{1}{x^2} + \frac{b_1}{2} + \frac{b_2}{3} 2x + \frac{b_3}{4} 3x^2 + \dots\right] = 0. \end{aligned} \tag{13}$$

Since the value of x is positive, then the solution of this equation $b_i = 0$. Therefore, the potential energy of the object in time always decreases (if the function is continuous on the given period of time) so that it does not decrease - the influx of external energy is required (which is consistent with the second law of thermodynamics).

Consider the case where $x = 1$. We define the slope of the tangent to the curve of potential at this point. Using the last expression, we can write:

$$\frac{d(B^*)}{dt} = \tan \alpha = \left(\frac{b_0}{1} + \frac{b_1}{2} + \frac{b_2}{3} + \frac{b_3}{4} + \dots \right) \frac{1}{1} + \frac{b_1}{2} + 2 \frac{b_2}{3} \times 1 + 3 \frac{b_3}{4} \times 1 + \dots = b_0 + b_1 + b_2 + b_3 + \dots \tag{14}$$

Based on the symmetry line of information to the line capacity, for a line of information we get the same angle of inclination, but in the initial coordinate with the opposite sign. We define the case:

$$\int_0^{t_L} B(t) dt = const = G = b_0 t_L + \frac{b_1 t_L^2}{2} + \frac{b_2 t_L^3}{3} + \frac{b_3 t_L^4}{4} + \dots,$$

if $t_L = 1, \text{TO } G_1 = b_0 + \frac{b_1}{2} + \frac{b_2}{3} + \frac{b_3}{4} + \dots$. (15)

Rewrite the expression (2) for the potential use of (5):

$$B^* = \frac{1}{x} \left(\frac{b_0}{1} + \frac{b_1}{2} + \frac{b_2}{3} + \frac{b_3}{4} + \dots \right) - \frac{b_0}{1} - x \left(\frac{b_1}{2} + \frac{b_2}{3} x + \frac{b_3}{4} x^2 + \dots \right) \tag{16}$$

Thus it is possible to rewrite the expression (4):

$$\frac{dB^*}{dt} = \tan \beta = - \left[\frac{1}{x^2} G_1 + \frac{b_1}{2} + \frac{b_2}{3} 2x + \frac{b_3}{4} 3x^2 + \dots \right]. \tag{17}$$

Current capacity of the object in this case is written:

$$P(t) = \int_{t_a}^{t_x} B^* dt = \int_{t_a}^{t_x} \left[\frac{1}{x} G_1 - \frac{b_0}{1} - x \left(\frac{b_1}{2} + \frac{b_2}{3} x + \frac{b_3}{4} x^2 + \dots \right) \right] dt.$$

If we consider the last expression and to determine the slope of the tangent to the curve at the point with $x \rightarrow 0$, we obtain a division by zero as $0 < t_a < t_x$, that does not make sense. Therefore, to determine the elastic modulus of the material at this point does not make sense. It is understood that at this point with abscissa $x = 0$ no defects. In fact, the actual initial material has defects that determine the slope of the tangent at the starting point of destruction. In this case, the modulus of elasticity is characteristic of "defects" and the material, initially, "defects" - "imperfections" in its structure, and then the "defects" - defects in its structure.

Previously obtained expressions for the potential of the object does not determine the elastic modulus of the material at the starting point, but its impact on subsequent behavior. If we take the original "defect-free" structure, rather than the value determined and accepted way to calculate power impossible.

Chart object behavior over time.

Depict the operation curve plotted material $P(t)$ in fig.11B. The abscissa axis

shows the power of the object, and the ordinate time. The total power of the object can be written $P(t) = P_{el} + P_{pl}$

Suppose we know the elastic modulus $E = 36 \times 10^3$ MPa and two specific points: 1st point: $P = 0.2 P_L$, $t_x - t_a \leq 0,05 t_x$; 2nd point: $P_L = 29$ MPa, $t_L = 220 \times 10^{-5}$. Then, based on the most recent entries, we obtain: chart material $E = 29,5 \ln \frac{t}{a} - 2393(a - t) + 1211(a^2 - t^2)$

The influence of a number of members with a degree higher than the third has practically no effect on the results of the calculation.

The initial modulus of elasticity, is a line $P_{el} = (tg \beta)t_a$. On the chart, this line becomes a potential horizontal line $B = (tg \beta) = E$, crossing the line potential at the point with abscissa $t = t_{a \min}$. This point marks the beginning of the destruction of the material and that from this point the elastic modulus of the object begins to decrease, as it creates additional defects. In some materials possible non-linear module, which characterizes the ability of a material to recover defects relieve tension.

Energy diagram of the material and their characteristic points are shown in fig.8. When analyzing the work place needs to consider a set of diagrams.

3. The interaction energies.

Consider the development of the object in the absolute numbers of time. For comparison, we choose the numbers comparable with the term of human life as the most perceptible. Figure 9 shows the development of the object when $L = 60$ years, 80 years, 100 years and 120 years ($t_0 = 0$, $B = 1$). Correlation lines with age can be determined on the horizontal axis. The distance between the lines of life converge over time: as the age of 1 year difference between adjacent lines is 20 s / s and 60 years of age difference is decreased and reached to 50 times with a 0.4 / s. On the other hand, if the absolute change y the properties of one and the same time slot in line with longer life greater the relative change (in relation to the primary value of y) is not dependent on the lifetime. The initial value of the property y proportion to the term of the life of L . The value of properties y the same age at relatively the same. Dotted lines in fig. 12 shows plots of accumulation of information (defects) for a lifetime of 60 and 100 years. Cross the line of the accumulation of life at the equilibrium points. The graphs show that a shorter lifespan accumulation of defects is much faster.

From the graphs in fig. 9 we get the following conclusions:

- restoration of the object in terms of changes in capacity (or treatment) is most effective in as many age (in some cases, the timing of exceeding the lifetime L);
- Receive defects (hurt) in the later stages of life is very dangerous (the slightest defect dramatically reduces the lifetime);
- treatment is less effective (in terms of growth potential, rather than energy expenditure) at an early age, but the disease at an early age are less dangerous;
- acquisition of knowledge at a younger age is more effective;
- On the other hand the loss of knowledge at an early age is more dangerous than in later life.

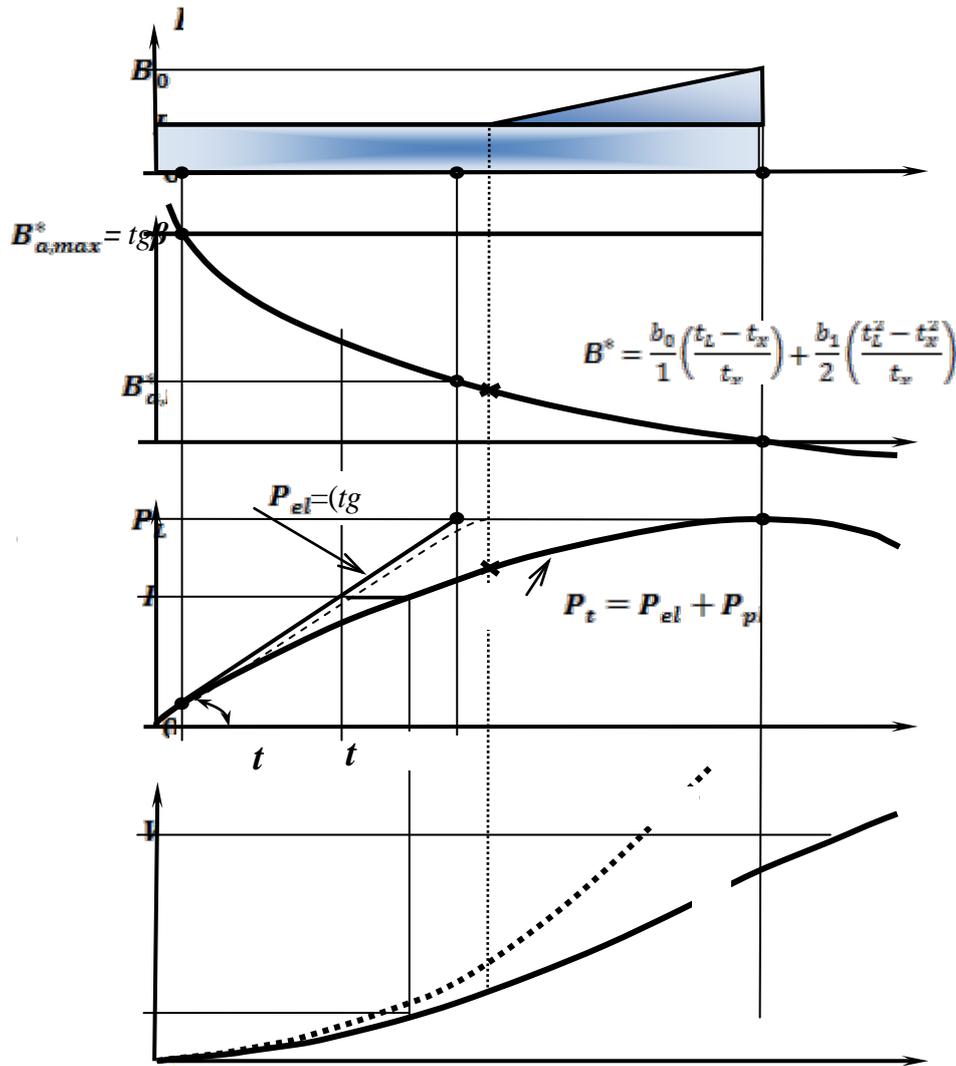


Fig.8. Combined chart object behavior over time
 a) The graph of acceleration energy; б) the schedule of building;
 в) the schedule of power; г) the schedule of energy.

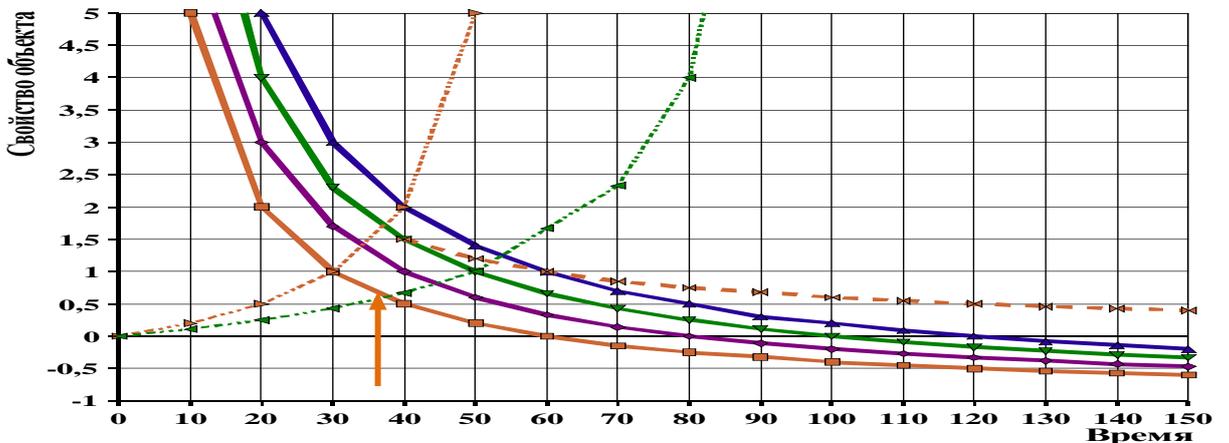


Fig.9. Changing object properties from time to time

Consider starting point $t_0 = 0$ life (with the uncertainty of the coordinate y). Indeed it is very difficult to determine the original energy value at this point. The

analysis shows that the value of the potential energy at this point is determined by the entire previous history of the world. This is where the communication capabilities. Otherwise, for each period of time can make their full potential.

There are local variations, racing object properties (recovery of emergency defect, disease, and others.). Figure 9. pointer property changes. Arrow may be inclined. In this example, a vertical arrow shows the increase in the properties of the object 1 at the lifetime of 40 years with a value of 0,5 to 1,5.

A further change in the properties of the object (if the assumed conditions) is possible only on the bottom line. Change the line parallel to the initial curve, it is impossible, since it leads to unlimited lifespan.

Therefore, increasing the property of a lifetime of 60 years at age 40 with a value of 0,5 to 1,5, we increase the life expectancy of the object up to 100 years. This assay can be used, for example, to estimate the time of repair construction: since restore structure with a lifetime of 10 years to 10 years, even 10-fold less efficiently than with a structure to restore life expectancy of 60 years to 10 years.

Increasing and decreasing acceleration energy.

Possible increase or decrease the acceleration energy in time fig.10. Figure 11 shows the change in the potential properties of the object in accordance with the charts of fig. 10. The bottom line on the graph (Figure 11) corresponds to a change of property 1 in fig. 10, the upper line represents the change in the properties of 15. The middle line in fig. 11 corresponds to the graph 8 in fig. 10.

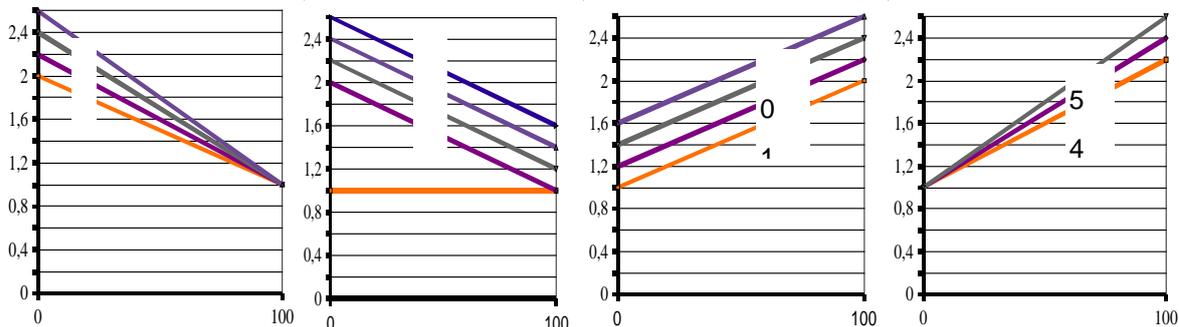


Fig.10. Options for change in the energy of the object

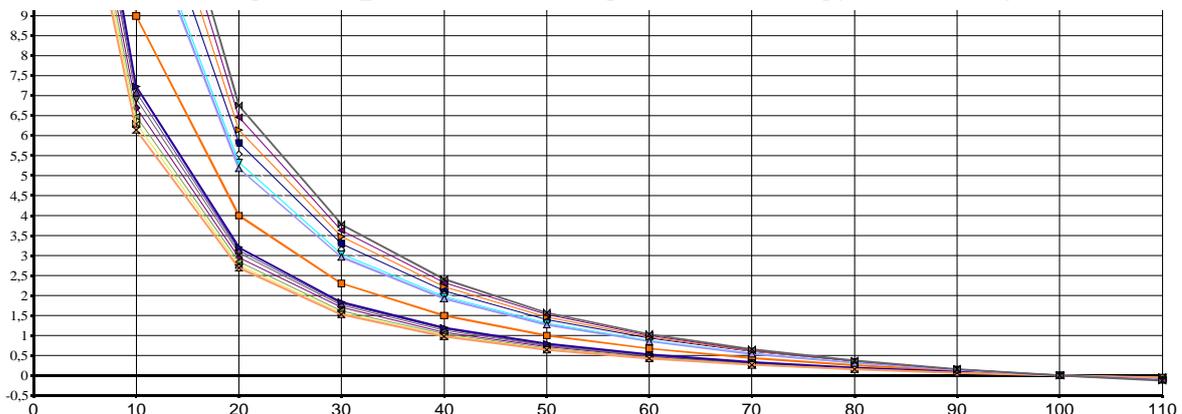


Fig.11. Graphs of the potential properties of the object in time when you change the properties of an object over time

If the increase in power as time record $b \pm ax$, when a equal to zero we obtain a comparison function in the already considered as $1/x - 1$, if $b = 0$ we obtain the

function as a $1/x^2 - 1$, regardless of the rise or descending energy. The eighth line represents the change in potential energy with a constant acceleration. Judging by the chart analysis of the behavior of the object in time when it is best to keep a constant energy. Energy change is easier to carry out an abrupt change in potential.

Effect of prior and future periods on the potential

Consider the circuit in fig. 12. In this scheme considered time interval $0 - L$ where acceleration energies from 0 to T_2 is zero, from T_2 to T_3 equals B, L and further to zero again. We show in Figure distribution of potential energy for this circuit: Line 1 corresponds to the distribution of the potential energy in the distribution of acceleration in the area T_2 to T_3 ; Line 2 corresponds to the potential of an ideal life (no expiration life - comparison formula L/x) on line 1; Line 3 corresponds to the distribution of the expected length of life potential at L (with the sharp drop in capacity in the end of life shows a small arrow); Line 4 corresponds to the ideal of life without end for her capacity to line 3 (with a sharp drop in capacity in the end of life shows a large arrow).

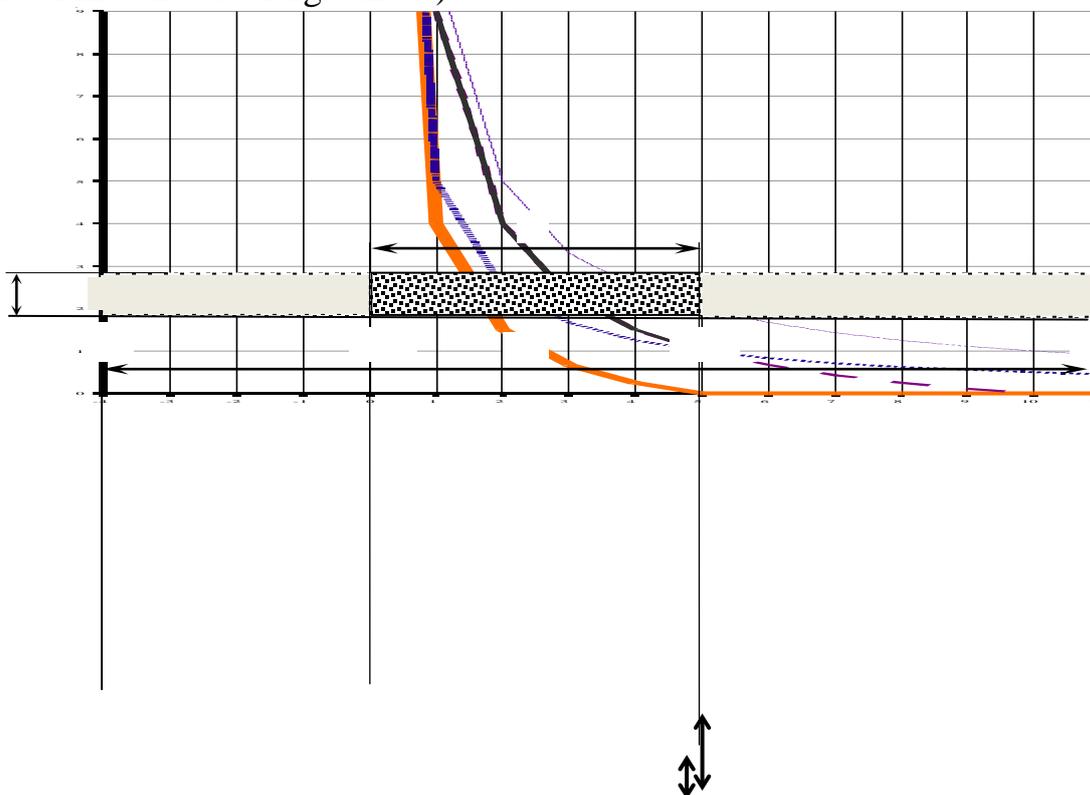


Fig.12. Distribution of relative potential energy in time for the chosen scheme of the energy distribution

As can be seen from fig. 12 the relative potential energy along the line 1 is slowly reduced to zero and then disappears (is equal to zero). Line 2 at the time of the disappearance of the acceleration energy is the potential drop by an amount depending on the expected lifetime. Relative potentials on lines 3 and 4 remain, but over time gradually decreases. However, the relation between the potentials at T_3 can be calculated. The difference between the potentials on lines 1 and 2 is always equal to one (if $B = 1$), the ratio between the implementation potentials (area under curve)

for lines 2 and 4 will be equal to the ratio of the ordinate at the point or the ratio L_1/L_2 . It should be noted that the expected life span may be less than the actual, in this case, a negative potential. This shows that different descriptions of the potential energy are interconnected regardless of the length of life, or the consideration of these potentials. On the other hand, for a particular property is not meaningful notion of time outside of his actions. Property (total) of the object, his life, is within the time does not exist. Leaving only traces in a modified matter. In certain cases, leaving traces is possible to recover the material properties of the object by a certain energy costs.

Interaction energies in time

All communication objects leads to an exchange of energy and, consequently, affects the change in potential energy of the object in time. In simplified form, take the total capacity of the object and consider the interaction of two similar objects. Figure 13 shows two objects with the same life span of 100 years, which are in contact at different times in his life: one with 50 to 60 years, with another 20 to 30 years. The acceleration energy of the first object 30, a second 40 conventional units. During the contact there was an exchange of energy in the 500 conventional units per year (this is a significant exchange of energy, equalizing power of interacting objects: $30 \cdot 100 + 500 = 40 \cdot 100 - 500 = 3500$). In this case, the first object, since 60 years, received an additional acceleration of $30 + 500/40 = 42.5$, and the second, since 30 years, and was decreased acceleration is $40 - 500/70 = 37.1$. However, this energy exchange is unlikely, correct $30 + 250/40 = 36.25$ and $40 - 250/70 = 36.42$. However, the graph Figure 16. shows the first case (as here the line graph diverge more and more clearly the changes). Growth capacity of the object increases the intensity or energy to increase the life expectancy of use while maintaining the intensity in the first case (an increase of 500 units) for 7.8 years (26% of the expected duration) in the second case 3.9 years. A second object or reduces the intensity or energy lost life expectancy in the first case 8.7 years (12.5%) and in the second case 4.4 years. However, with the accumulated information is reversed - the first object loses and the other gains in the same proportions as the energy. Power consumption in the first object on survival in the first case $7,8 \cdot 42,5 = 331$ (less wasted 500) and second case $3,9 \cdot 42,5 = 165,8$ (less than 250), and the second object in the first case $8,7 \cdot 37,1 = 322$ (less than 500) and in the second case $4,4 \cdot 37,1 = 163,2$ (less than 250). In both cases, the power consumed less energy survival (the beneficial effect of 67 ... 66%), while the power expended energy lost less (64 ... 65%). Some of the energy is lost with increasing life expectancy, as part offset by a decrease at her. Therefore the intensity reduction is not always life to increase its duration, the effect leads to the justified. More profitable to spend part of his life (optimal) to increase the memory, because the increase here is more effective than the gain in time. This is due to the change in the curvature of the line capacity.

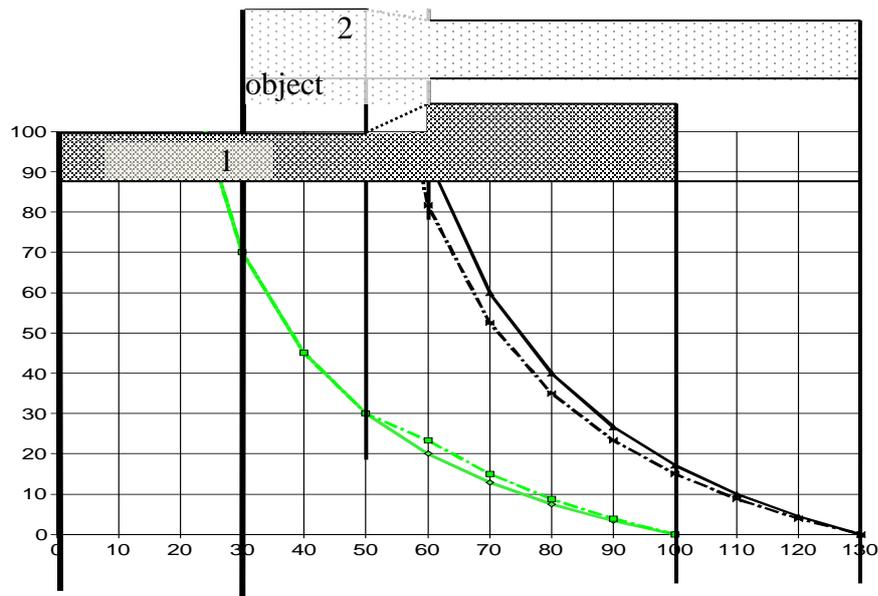


Fig.13. Charts interaction energies

Conclusions.

1. Assumptions made it possible to describe the development of the technology, which is characterized by certain features from the moment of its formation and until the emergence of a new, more efficient technology (characterized by their attributes).

2. The development of technology is characterized by two phases of efficiency. The first stage - the elastic or ageless, operation of the facility is 15 ... 68% of the total duration of use of technology. Second stage- dying, stretched all the time and the use of technology is characterized by a constant decrease its effectiveness ..

3. Technology can be upgraded by spending a certain energy at every stage of its work. Efficiency depends on the modernization of the energy applied and the time of modernization.

4. If the emergence of technology corresponds to the total potential of the time, its development will be smooth, otherwise there may be sharp breaks and transitions to other technologies.

5. Turning to the overall process different technologies are not always effective. Better technologies may be constrained by older technologies.

6. In general, the proposed approach to the evaluation of the behavior of an object-technology in a temporary space does not contradict the existing ideas about the development of technology and can be used to analyze and predict the behavior of technology development in time.

7. In the simplest case, the distribution of energy in time the remaining duration of the effective use of technology (durability) already used in the notation can be written

$$y = [1 - 0,1585e^{(0,8415 + \frac{B_1}{B^2 + B_1})}]L$$

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REVIEW OF MODERN MATERIALS RESEARCH SOFTWARE FOR COMPUTERS IN PROCESSING METALLOGRAPHIC IMAGES*Lutsk national technical university*

Abstract. *A complex analysis to the modern methods of researches of microstructures of porous penetrating materials is given. It is shown from the analysis of modern literary sources that macroscopic behavior and topology of surface directly depend on the features of his microstructure. Therefore measuring and control of properties of initial powders and finish goods modern facilities and software are by an important factor for making of high-efficiency and progressive porous penetrating materials.*

Possibilities and estimation of modern software are shown for computer facilities of research at processing of metallography images of different sort of materials. It is educed that the study of possibilities and estimation of modern software for computer facilities of research of metallography images with the aim of determination of quality and quantitative descriptions of materials is dictated by scientific and productive tasks that arose up in modern learn of materials.

It is well-proven in this article, that presentation modern programmatic foods for the analysis of micro images are an universal instrument for the quality analysis of image of structure of porous penetrating materials in science and on a production.

The brought methods over of non-destructive and rapid control, that determine and analyse the changes of structure of material, can be successfully used as an instrument of control of quality of the prepared product.

1. Introduction.

Swift development of the computing engineering and methods of the digital processing of images gave an opportunity considerably to extend automation of research works in many areas of SciTech lately. Macroscopic behavior of material directly depends on the features of his microstructure. Quantitative approach in analyzing allows to educe the optimal structure that fits the terms of service of material the best.

On the other hand, the successful decision of basic tasks of development of the world nowadays is determined by the increase of competitiveness of products produced. It pulls out rigorisms to the cleanness of materials, liquid and gaseous working environments of technological processes, reliability and longevity of work of machines, devices and etc. [14].

Powder metallurgy demonstrates advantages that allow to get materials with the best or very new qualities, or to make wares most economical by an advantageous method. Such wares are porous penetrating materials (PPM) which is used practically in all branches of industry [15].

Creation and development of new, highly-efficient PPM is impossible without measuring and control of properties of initial powders and ready goods. PPM is characterized by the row of structural and operating parameters which usually, are

determined by qualities of initial powders and technology of their production. Porosity, its distribution on the PPM, its kind (open, closed, dead-locked); form, sizes of pores (middle and maximal), coefficient of sinuosity of pores; coefficient of regularity of porous structure; penetrating coefficient; specific surface; mechanical durability, corrosive firmness and others. Can be named as important descriptions of PPM[1].

2. Analysis of the last researches and publications.

Study of structural descriptions of PPM is one of the key tasks of modern learn of materials on the basis of which the process of creation of new and improvement of properties of already existent materials is based. Realization of high-quality metallography analysis is related to the known difficulties that are determined by large by physical load on the organism of researcher (in particular organs of sight), subjectivity of supervisions and small speed of research process. Application of devices, that work on the basis of linear mechanical involute of optical objects brings in the limits on interpretation of signals that turn out, and also deprives possibilities of "intellectual" interference with the process of measuring [10, 4].

So as small changes at an analysis and processing of images have large influence on the further fate of finished product, the methods of non-destructive and rapid control, that determine and analyse these changes, can be successfully used as an instrument of control of product quality [7].

The study of possibilities and estimation of modern software for computer facilities of research of metallography images with the aim of determination of quality and quantitative descriptions of PPM is dictated by scientific and productive tasks that arose up in modern learn of materials.

Metallography images can be presented by combination of various structural constituents at different correlation: by phases, that are characterized by various sizes, form and color, and also by the limits of grains that can be presented or by separate lines dark-and-light, or to cover an image a continuous net. Combination of these structural constituents can give a very complicated picture, to interpret which program that analyses must own a great enough part of rightness of implementation. Therefore the basic requirement to the quality analysis of images can be set forth and put so: on the photo got under a microscope it is necessary to distinguish structural constituents, and after it to classify them on brightness, size and form. Practical realization of this point includes such tasks which have already become classic, as segmentation, filtration of defects and selection of objects from a background, determination of limits of objects, recognition of patterns [13]. For successful realization of metallography analysis the basic are complicated question remains in reliability of image segmentation. As far as metallography images are complicated there is not a single possibility to define descriptions of objects in good time. Therefore a process of segmentation must be adaptive and if possible to distinguish all objects of interest regardless of their sizes or brightness. Thus there must be possibility of intervention from an operator in the process of recognition, at least for the correction of object [6].

That is why volume, study and perfection of metallography methods and computer facilities for measuring, analysis, determination, treatment, and

prognostication of properties and structure of PPM are an actual and practical task.

3. Statement of research objectives

- describe for the metallography analysis of "*PHOTOM*", "*OPTIMAS*", "*VIDEOTEST*", "*IMAGE EXPERT PRO*", "*AVIZO*", "*SMART - EYE*[®]"
- Possibilities and evaluation of advanced software tools for computer research in the processing of metallographic images.

4. Results.

The modern stage of development of software is characterized together with the increase of functionality and such tendencies, as:

- Its simplicity in exploitation;
- Increase of the productivity by the system itself;
- Decline of requirements to the professional level of the user.

Today there are many various application programs for the analysis of images. Products that are the simplest in exploitation become the most successful.

Taking into account functional possibilities among the variety of software for the analysis of images the most successful are the next application programs - "*PHOTOM*", "*OPTIMAS*", "*VIDEOTEST*", "*IMAGE EXPERT PRO*", "*AVIZO*", "*SMART-EYE*[®]" and many others.

In the arsenal of these programs there are all the algorithms which are needed for processing of technical images [9]. They are high-frequency and low-frequency filtration, selection of limits of images, arithmetic and logical operations, brightness/contrast correction and others. In this case treatment of image is sent not to the improvement of visual perception, but on his preparation to the further analysis.

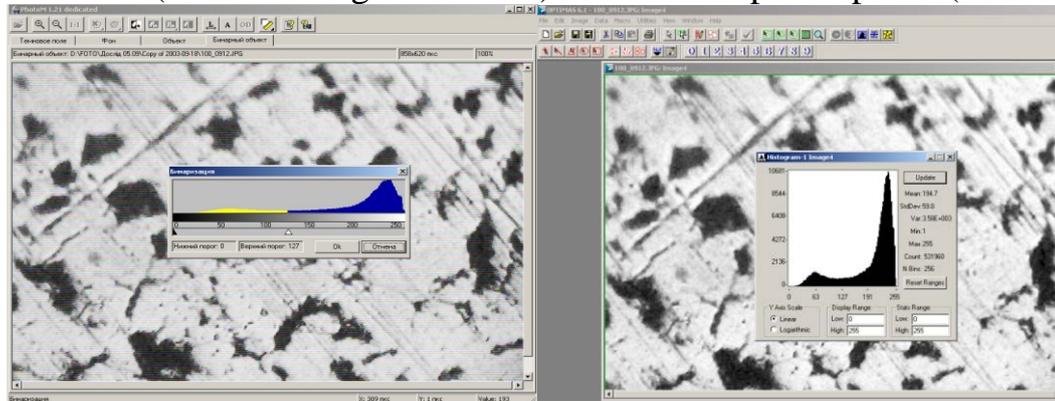
In the arsenal of these modern programs there are all the algorithms are needed for processing of technical images [2,5,15]: high-frequency and low-frequency filtration, selection of limits of images, arithmetic and logical operations, correction brightness/contrast and others. Treatment of image in this case is focused not on the improvement of visual perception, but on his preparation to the further analysis.

On the basis of analysis of mentioned above algorithms these programs allow to calculate the average brightness of every object according to the brightness scale, fixed in the systems. By means of this chart in all application programs of this specific the next sequence of algorithms is offered to treat and obtain descriptions of metallography structure:

1. Filtration of image with the aim of exception of casual noise.
2. Previous segmentation focused on the selection of homogeneous areas.
3. Correction of object with the aim of determination of its threshold of brightness.
4. Final segmentation with the use of the defined base-line value, that allows to fully define objects.
5. Analysis of the distinguished objects with the aim of determination of their parameters.

It follows to consider statistical treatment of the descriptions of objects, determination of mean values of these sizes got in the process of measuring the eventual task of metallography analysis, and also construction of graphic dependences for visualization of process of analysis.

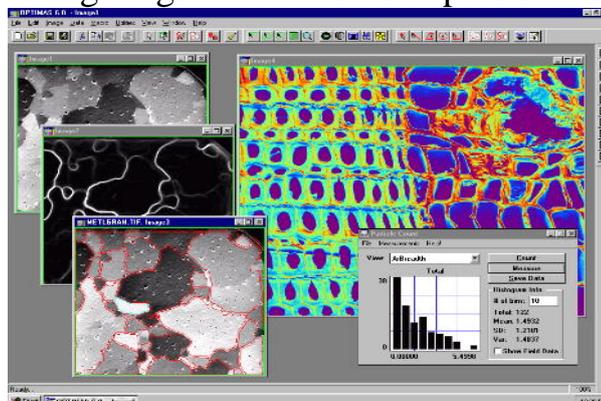
The easiest in use and determination of these descriptions there is the program "PHOTOM", that is intended for photometry. Loading of black and white images comes true in format .BMP and .JPG. This program carries out the calculation of absorbency of photos, that settles accounts taking into the consideration background both in the medium (on the distinguished area) and in the separate photo (Picture.1).



Picture.1 Generate of binary image and construction of histograms of analysis of structure to the micro section of porous penetrating material got from powder of steel of BBS15

Besides the calculation of absorbency it is possible to invert, to increase the contrast and smooth out an image, generate a binary image, determine distances between objects and carry out the calculation of the necessary area in the photo. Moreover there is also provided mode of calibration to count all coordinates in metrical units (microns).

The analyzer of images of "OPTIMAS" is an soba integration of modern methods on processing of images created on the basis of powerful mathematical methods tested in practice. A wide row of unique functions and methods of work is worked out specially for this program. Two control panels are created: standard tuning and tuning of user. The standard tuning gives button access to treatment of file, clipboard and printing actions; tuning of user allows to appoint up to twenty other macro instructions to the panels of user. There is an automatic threshold for multiphase images; possibility of reflection of histogram, due to the use of more flexible and functional tool of graphic – display of histogram (Picture.2); maintenance of automatic image segmentation in the specified amount of intensity.



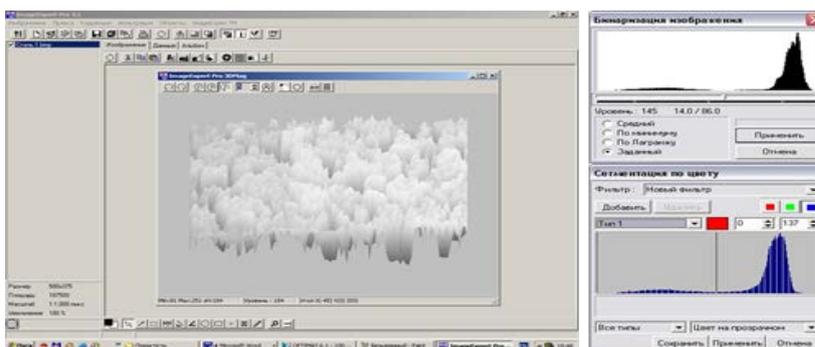
Picture 2. Maintenance of automatic image segmentation with the reflection of zones of particles of powder of porous penetrating material

The mounted mechanism of automation is absolutely transparent for the user

and allows without excessive efforts on the program to accumulate and analyze data from many points of view, to get integral descriptions and pore distribution.

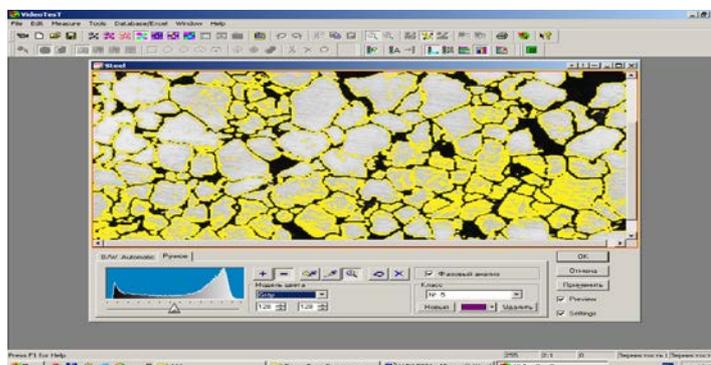
The result of the program **"IMAGE EXPERT PRO"** performance is received of quality and quantitative descriptions of structures. For material connoisseur in this case there can be distribution of grains according to points, percentage ratio of phases in the structure, amount of switches and their division according to size and form, analysis of textures, porosity and others. This analyzer of metallography images allows to create and keep the charts of actions performed over images, and then apply these charts to the similar images. The obtained data can be presented also as histograms, as well as tables, images, average or general data after all objects or individually on each.

As for as the innovations are considerate unlike the previous programs, it is possible to mention: facilities of work are mounted with a video camera, possibility of calibration of the optical system of the complex, dynamic mode of revision for most methods, automatic division of recovering objects, complex reflection of results, fine-tuning of the modes of conclusion of results and special difference is possibility of fully automatic formation of quality sharp image of three dimension object (Picture3).



Picture 3. The automatic formation of quality image of a three dimension object of structure of the micro section of porous penetrating material and presentation of results

The substantial difference of program **"VIDEOTEST VT4"** from previously presented, ones where the process of segmentation is built on the principle of adaptive binarization is the division of objects according to their medium brightness (Picture 4).



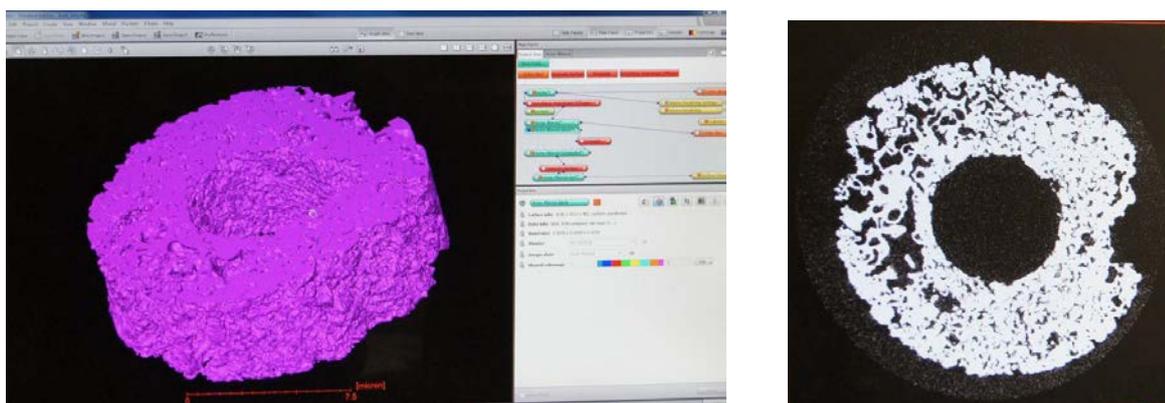
Picture 4. Determinations of division of objects of image according to their medium brightness by means of the program "VIDEOTEST VT4"

The difference of this program is in possibility of determination of phase

analysis of any material, marking the image of masks to determine size of pores and porosity of alloy. The specific feature of this software product is possibility to the control process of growth of thin film coverage with stable functional properties.

Many tasks of industrial control and planning require the receipt of data about the geometrical forms of objects in three-dimensional space. To solve these tasks the noncontact methods of measuring are widely used optical methods are among that most successful [11-12].

Formation of 3d-image by means of software environment of "AVIZO" comes true by imposition of flat transverse sections of appropriate range on the height of the prepared porous powder-like material (Picture5).



a)

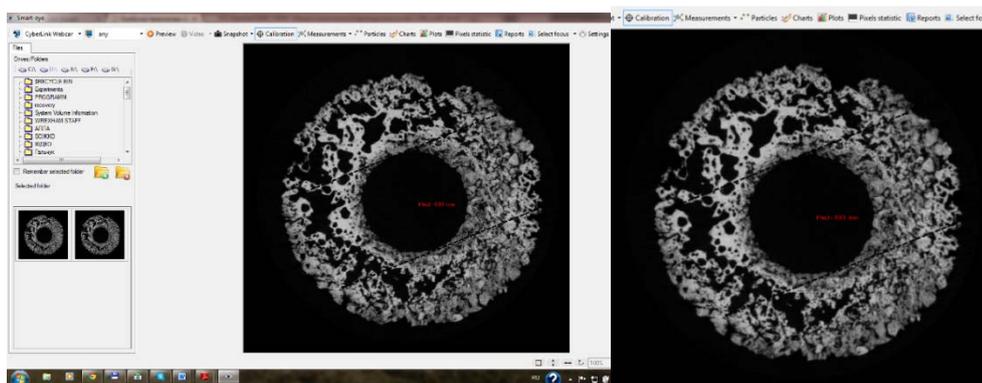
b)

Picture 5. Visualization of the received image of transversal cut of porous powder-like material : a) 3d-image with the use of "AVIZO"; b) sciagram

The essence of the work of "AVIZO" is based on system understanding of morphology and microstructure of the pre-production model. This knowledge has a near-term value at the estimation of quality of the prepared product. For the complete and quality estimation of standard it is necessary to define and investigate the basic morphological parameters of structure, namely:

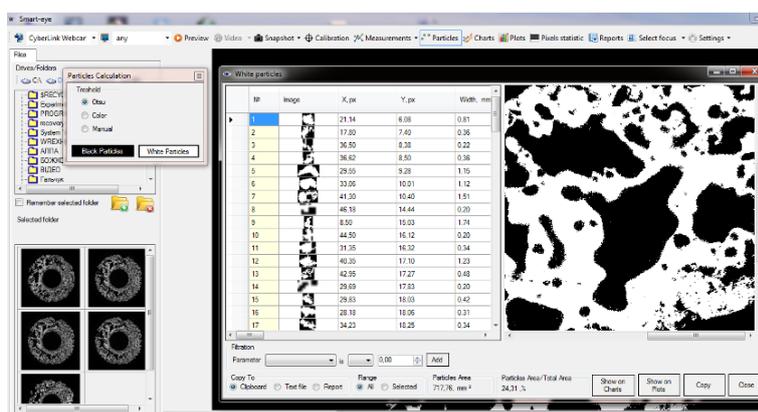
- Determination of the amount of particles of different size and form;
- Determination of structural defects of the standard;
- Determination of form of pores and forms of particles;
- Determination of general distribution of pores in a cut and on all volume;
- Determination of general distribution of certain form particles on a perimeter and volume.

In general the quality analysis of image of finish product - porous penetrating material - is conducted to of determine such parameters of objects as a medium brightness, perimeter, area, minimum and maximal diameters, factor of the form, coefficient of form and other [3-16]. By means of other application program "SMART - EYE®" it is possible to define these descriptions, necessary for a quality and quantitative estimation structures of any material, including porous (Picture6).



Picture 6. A process of calibration of standard and introduction of the real dimension by means of the program "SMART - EYE®"

The eventual task of metallography analysis by means of "SMART - EYE®" is to count statistical treatment of the descriptions of objects, determination of mean values of these sizes got in the process of measuring, and also construction of graphic dependences for visualization of process of analysis (Picture6).



Picture 7. Determination of form and sizes of pores of pre-production model

In order to get more adequate estimation of the received results by means of "SMART - EYE®", binarization image must be conducted. Essence of binarization lies in consideration of enormous quantity of probable variants. In this case, binarization consists in regeneration of grey picture of micro section image in a raster black and white picture.

Conclusions. Thus, programmatic products described for the metallography analysis of "PHOTOM", "OPTIMAS", "VIDEOTEST", "IMAGE EXPERT PRO", "AVIZO", "SMART - EYE®" are effective enough to solve intricate problems of modern computer learn of materials. These software for the analysis of micro images are the universal instrument for the qualified analysis of image in science and in industry, equally irreplaceable both at the analysis of laboratory structures and at a quantitative analysis according to the Ukrainian and international standards.

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**CREATING A SYSTEM OF INFORMATION SECURITY
OF MULTISERVICE NETWORK RESOURCES OF TRANSPORT
SECTOR PROVIDED ON THE BASIS OF THE OPEN SYSTEM
INTERCONNECTION MODEL**

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Introduction

For determination of uniform level of access for subjects to the information objects which are primary information unit, the information security system of MSTO has to provide possibility of the following distribution of access:

- to group or several groups of objects;
- to object;
- to a set of parts of object.

For example, if information objects are clients, there has to be a possibility of definition of uniform access to clients for the specific user by the following criteria:

- specific client;
- all clients of type A and B;
- only a number of fields in the client's card.

Access to information objects has to include the following types of restrictions:

- there is no access to object;
- access (to object/part of object) only on reading;
- access (to object/part of object) only on change - separately with reading and without reading;
- removal of information object;
- addition of information object;
- there is no access to reading;
- there is no access to change;
- there is no access to addition;
- there is no access to removal.

For achievement of the greatest objectivity when developing methods and technologies of ensuring information security of MSTO we will consider reference model of interaction of open systems - Open System Interconnection (OSI).

Information systems on transport in the general set use all levels of the OSI model, however each system separately can use some concrete levels.

Data transmission safety methods – physical level

At the physical level safety of data transmission directly depends on ensuring security of the environment of transfer.

We will consider some data links, used on transport:

- Wire channels: twisted couple, coaxial cable, optical fiber, etc.

Safety of data transmission on twisted couple depends on a choice of its look differing in extent of shielding. Respectively – the extent of shielding is higher – the

degree of safety of data transmission is higher.

- Coaxial cable. In transport information systems the coaxial cable is applied first of all in video information systems.

Among properties of information which should be considered first of all at data transmission on a coaxial cable, it is necessary to allocate – availability and integrity.

It should be noted that thanks to the geometry and physical properties the coaxial cable is less subject to aimings and has smaller extent of attenuation of a signal.

From the point of view of attacks to integrity of the cable line it is necessary to apply additional measures for protection, concealment of a data line which don't depend on a type of a cable.

- Fiber-optical cable. From the point of view of safety the fiber-optical cable undoubtedly has more advantages in front of other wire channels. Its main advantages: a wide pass-band, small attenuation of signals, lack of electromagnetic hindrances, range of transfer on tens kilometers, service life more than 25 years, etc.

- Wireless channels: wi-fi, radio channel, technologies of satellite communication: GLONASS, etc.

In wi-fi channels many articles, in particular, were devoted to data security. Therefore in this work we won't pay separate attention to the matter.

Data security, transferred on radio channels taking into account physical specifics of the channel, has to provide stability of operation of the channel and due quality of a signal. It can be provided with use enough powerful send-receive stations.

Data transmission safety methods – channel level

Channel level provides necessary reliability of information transfer which defines degree of compliance of the accepted message to the transferred. At this level there are such operations as formation of a shot, calculation of control sequence of a shot, control of mistakes in the accepted shot. Excess categories which are calculated on a certain algorithm are entered into structure of each shot. The accepted shot is analyzed on compliance to the rule of coding, and in case of violation of the rule the host transfers the message on it to the transferring party. It should be noted that channel protocols of some high-speed networks don't correct an error. This problem is solved by protocols of top levels of a stack of OSI.

Data transmission safety methods – network level

At this level of the OSI model protocols allow to overcome the restrictions imposed by specifications of channel level (for example, at this level it is possible to make absolutely exact identification of knots).

Important way of safety at the network level is implementation of the scheme of separate addressing as groups of the connected devices, and separate knots. The protocol of the network IP level which allows to identify both number of a network, and number of knot can be an example (thus the address in this protocol is set). Important opportunity also is the task of the maximum number of knots of a network by means of a mask task.

Data transmission safety methods – transport level

On transport level data transmission safety first of all is possible with use of

high-quality mechanisms of multiplexing with control summation. Thus it is possible to control preservations of property of data – integrity.

Data transmission safety methods – session level

At the session level there is a providing communication sessions. Here it is possible to identify communication sessions and to operate possibility of connection, giving commands on lower levels. The mechanism of control of integrity and availability of data is possibility of establishment of control points in the transferred messages for restoration in case of a rupture of connection.

Data transmission safety methods – data presentation level

The main possibility of safety of data transmission at the level of representation is defined also by the main function of this level – coordination of the data which are transferred between various platforms.

Data transmission safety methods – applied level

The main mechanism of data security at the applied level in transport IS is enciphering. At the moment algorithms of enciphering there was rather large number and use of this or that algorithm is defined by category of the processed data, computing power of devices and, the most important, financial expediency.

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SIMILARITY AND DISSIMILARITY MEASURES AS OBJECTIVE FUNCTION IN IMAGE REGISTRATION

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Introduction

Digital image registration is a process by which the most accurate match is determined between two images, which may have been taken at the same or different times, by the same or different sensors, from the same or different viewpoints. The registration process determines the optimal transformation, which will align the two images. This has applications in many fields as diverse as medical image analysis, pattern matching and computer vision for robotics, as well as remotely sensed data processing. In all of these domains, image registration can be used to find changes in images taken at different times, or for object recognition and tracking. As well as geometric deformations images to be aligned can have different types of linear and non-linear intensity distortions that can appear due to changes in lighting conditions, implementation of different sensors, shadows etc.

There are image registration methods implemented in both spatial and Fourier domains. Fourier domain methods are based on phase correlation. The first method of this type was first implemented for estimation of spatial translations in [1]. After that there appeared some modification of the method by means of log-polar transformation [2]. It made it possible to estimate not only translations but rotation angle and scale factor [3]. In [4] the phase correlation method invariant to central-symmetric blur is proposed. Later, some phase correlation based methods providing sub-pixel accuracy were considered [5, 6]. In [7] the image registration method using correlation coefficient in Fourier domain is proposed. However, serious drawbacks of Fourier domain methods are computational complexity and limitation on deformation models. These facts make it difficult to implement such algorithms in modern data processing systems.

Spatial domain methods operate directly on pixels, and the problem of the estimation of registration parameters $\bar{\alpha}$ becomes the problem of searching for the extreme point of a multi-dimensional objective function $J(\mathbf{Z}^{(1)}, \mathbf{Z}^{(2)}, \bar{\alpha})$. The objective function measures the similarity between two images $\mathbf{Z}^{(1)} = \{z_{\vec{j}}^{(1)}\}$ and $\mathbf{Z}^{(2)} = \{z_{\vec{j}}^{(2)}\}$, where $\vec{j} \in \Omega$ are nodes of grid mesh $\Omega: \{\vec{j} = (j_x, j_y)\}$ on which the images are defined. There is a wide variety of similarity and dissimilarity measures that can be used as objective functions [8]. The decision of which objective function to choose is usually based on the specifics of images, deformation properties and conditions. The analysis of some most frequently used measures is given below.

1 Similarity measures

Similarity measures show how similar (in terms of some values) the images are. Moreover, the greater the similarity measure the more similar images are.

Correlation coefficient

One of the most used similarity measure in image registration is correlation

coefficient [9-11]. It is defined as

$$r = \frac{\sum_{\bar{j}_t \in \Omega_t} (\tilde{z}_{\bar{j}_t}^{(1)} - M[\tilde{\mathbf{Z}}^{(1)}])(z_{\bar{j}_t}^{(2)} - M[\mathbf{Z}^{(2)}])}{\mu \hat{\sigma}_{z_1} \hat{\sigma}_{z_2}},$$

where μ – the number of pixels in a sample, $\tilde{\mathbf{Z}}^{(1)}$ – continuous image obtained from $\mathbf{Z}^{(1)}$ using current deformation parameters $\bar{\alpha}$ and an interpolation technique; $\hat{\sigma}_{z_2}^2 = \sum_{\bar{j}_t \in \Omega_t} (z_{\bar{j}_t} - M[\mathbf{Z}])^2 / \mu$ – an estimation of image \mathbf{Z} variance; $M[\mathbf{Z}] = \sum_{\bar{j}_t \in \Omega_t} z_{\bar{j}_t} / \mu$ – an estimation of image \mathbf{Z} mean value. Correlation coefficient r takes values between -1 and $+1$. The value $r=+1$ stands for absolute linear correlation, and $r=-1$ – for inverse correlation. If r is differ from ± 1 then the relationship between $z^{(1)}$ and $z^{(2)}$

can be expressed by the equation [9] $z_{\bar{j}_t}^{(2)} = \frac{\hat{\sigma}_{z_1}}{\hat{\sigma}_{z_2}} (\tilde{z}_{\bar{j}_t}^{(1)} - M[\tilde{\mathbf{Z}}^{(1)}]) + M[\mathbf{Z}^{(2)}]$ which measures the linearity between $\mathbf{Z}^{(1)}$ and $\mathbf{Z}^{(2)}$.

Correlation coefficient is quite effective measure in terms of computational complexity because it requires not many additions and multiplications for each pixel in a sample. Computational complexity of correlation coefficient is on the order of μ .

The fact that correlation coefficient takes into account the linearity of images' intensities makes this measure robust in case of additive noise and linear intensity distortions.

Tanimoto coefficient

Tanimoto coefficient between two images is defined as [12]:

$$S_T = \frac{\sum_{\bar{j}_t \in \Omega_t} \tilde{z}_{\bar{j}_t}^{(1)} z_{\bar{j}_t}^{(2)}}{\sum_{\bar{j}_t \in \Omega_t} \tilde{z}_{\bar{j}_t}^{(1)} z_{\bar{j}_t}^{(2)} + \sum_{\bar{j}_t \in \Omega_t} (\tilde{z}_{\bar{j}_t}^{(1)} - z_{\bar{j}_t}^{(2)})^2}.$$

Tanimoto coefficient is very close to correlation coefficient. Here the normalization of intensity multiplication with respect to their standard deviations is replaced by the normalization with respect to the sum of squared differences between corresponding sample counts, which effects in the same way. Using the inner product of intensities in the denominator of Tanimoto coefficient gives the same effect as the normalization with respect to mean values of images.

Computational complexity of Tanimoto coefficient is on the same order as for correlation coefficient.

Minimum ratio coefficient

Minimum ratio coefficient for a pair of images $\mathbf{Z}^{(1)}$ and $\mathbf{Z}^{(2)}$ is defined as [8]

$$m_r = \frac{1}{\mu} \sum_{\bar{j}_t \in \Omega_t} r_{\bar{j}_t},$$

where $r_{\bar{j}_t} = \min(\tilde{z}_{\bar{j}_t}^{(1)} / z_{\bar{j}_t}^{(2)}, z_{\bar{j}_t}^{(2)} / \tilde{z}_{\bar{j}_t}^{(1)})$.

If images do not have noise and geometric deformations the value $r_{\bar{j}_t}$ is equal to 1 for each pair of pixels, therefor, the minimum ratio coefficient m_r is equal to 1. If

corresponding pixels' intensities do not have any relationship, the ratios $\tilde{z}_{j_i}^{(1)} / z_{j_i}^{(2)}$ and $z_{j_i}^{(2)} / \tilde{z}_{j_i}^{(1)}$ are very different (one of them is much greater than another). Hence the value of m_r is much less than 1. As closer m_r to 1 as more similar images are.

Using intensities ratio instead of their difference decrease sensitivity of this measure to noise. However, the efficiency of minimum ratio coefficient decreases considerably in case of occlusions on images, correlated noise and non-linear intensity distortions.

In terms of computational complexity, this measure is highly efficient as it requires μ additions, comparisons and $2\mu+1$ divisions.

Spearman correlation coefficient

Spearman correlation coefficient [13] is the correlation coefficient computed in terms of intensity ranks rather than their values. It can be calculated as follows [14]:

$$\rho = 1 - \frac{\sum_{j_i \in \Omega_i} (P(\tilde{z}_{j_i}^{(1)}) - P(z_{j_i}^{(2)}))^2}{\mu(\mu^2 - 1)},$$

where $P(\cdot)$ – image intensity rank.

To decrease the effect of image quantization they are first smoothed, e.g. with Gaussian filter with small standard deviation about 1.

Computational time of ρ is much greater than r due to the requirement of intensity ranking which requires about $\mu \log_2 \mu$ comparisons. This measure is less sensitive to noise and occlusions than correlation coefficient. If images do not have noise or occlusions and images' intensities have linear relationship then Spearman correlation coefficient is not better in comparison with correlation coefficient.

Ayinde and Yang [15] compared efficiency of correlation coefficient and Spearman correlation coefficient for face recognition problem. They concluded that in case of non-linear intensity distortions and occlusions ρ is always much better than r . Muselet and Tremeau [16] proposed a method of object recognition based on rank correlation of color components.

Kendall correlation coefficient

If $\tilde{z}_j^{(1)}$ and $z_j^{(2)}$ are intensities of corresponding image pixels then for $i \neq j$ there are two possible situations: $\text{sign}(\tilde{z}_i^{(1)} - \tilde{z}_j^{(1)}) = \text{sign}(z_i^{(2)} - z_j^{(2)})$ or $\text{sign}(\tilde{z}_i^{(1)} - \tilde{z}_j^{(1)}) = -\text{sign}(z_i^{(2)} - z_j^{(2)})$. The first case is called concordance, the second – mismatch. If we take a large sample from images and the number of concordances is greater than the number of mismatches then we can conclude that image intensities are bounded. Let assume that from $\mu/2$ pixel pairs N_c are concordances and N_m – mismatches, then Kendall correlation coefficient can be defined as follows [17]

$$\tau = \frac{2(N_c - N_m)}{\mu(\mu - 1)}.$$

In [18] it is shown that if images have probability distribution function of intensities close to Gaussian then Kendall correlation coefficient is related to correlation coefficient by the following equation

$$r = \sin\left(\frac{\pi\tau}{2}\right).$$

This equation shows that correlation coefficient is more efficient if probability distribution function of intensities is close to Gaussian. However, Kendal correlation coefficient determines similar images better.

Kendal correlation coefficient is one of the most complex measures in terms of computational complexity. It requires concordance and mismatch computations for $\mu(\mu-1)/2$ corresponding pixel pairs. Therefore, its computational complexity is on the order of μ^2 operations.

Greatest deviation coefficient

As the previous measure greatest deviation coefficient uses intensities' ranks rather than their values. It can be calculated using the following equation [19]

$$R_g = \frac{\max(\mathbf{D}) - \max(\mathbf{P})}{\mu/2},$$

where $P_i = \sum_{j=1}^i I[P(z_i^{(1)}) \leq i < P(z_j^{(2)})]$, $D_i = \sum_{j=1}^i I[\mu + 1 - P(z_i^{(1)}) > P(z_j^{(2)})]$, $I[x]=1$ if x is true otherwise $I[x]=0$, i, j – positions of points in the sample.

Table 1 shows an example of **D** and **P** calculation.

For instance, according to table 1

$$R_g = \frac{3-6}{8} = -\frac{3}{8}.$$

Greatest deviation coefficient takes on values between -1 and 1. The same as Spearman and Kendall correlation coefficients this measure is less sensitive to noise and occlusions in comparison with correlation coefficient. However, without these factors correlation coefficient is more efficient.

In the same way as for all measures using intensities' ranks, to increase the estimation quality preliminary image smoothing with Gaussian filter with 1 pixel standard deviation is recommended.

Table 1

<i>i</i>	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
$\tilde{z}_i^{(1)}$	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
$z_i^{(2)}$	14	11	16	2	12	13	7	9	10	3	8	1	15	6	4	5
P_i	1	2	3	3	4	5	5	6	6	5	4	3	3	2	1	0
D_i	1	2	1	2	2	1	2	2	2	2	2	3	3	2	1	0

In terms of computational complexity this measure is more complex even then Kendall correlation coefficient.

Ordinal measure

This measure is very close to greatest deviation coefficient. The only difference is that it uses just D_i coefficients [20]:

$$R_o = \frac{\max(\mathbf{D})}{\mu/2}.$$

It requires two times less operations than greatest deviation coefficient but on the same order.

Correlation ratio

Correlation ratio first was proposed by Pearson [21]. To compute correlation ratio for images $\mathbf{Z}^{(1)}$ and $\mathbf{Z}^{(2)}$ for each intensity in $\mathbf{Z}^{(1)}$ corresponding image intensities in $\mathbf{Z}^{(2)}$ are found. If each intensity in $\mathbf{Z}^{(1)}$ corresponds to only one intensity in $\mathbf{Z}^{(2)}$ than there is a unique transformation mapping intensities of one image into another. Otherwise one intensity value in $\mathbf{Z}^{(1)}$ corresponds to several intensities in $\mathbf{Z}^{(2)}$. The dispersion of corresponding values can be estimated via standard deviation

$$\sigma_i = \left[\frac{1}{n_i} \sum_{z_i^{(1)}} (\mathbf{Z}^{(2)}(z_i^{(1)}) - m_i)^2 \right]^{1/2},$$

where n_i – number of intensities $\mathbf{Z}^{(2)}$ corresponding to intensity of the i -th pixel $z_i^{(1)}$ in the sample, $\mathbf{Z}^{(2)}(z_i^{(1)})$ – intensity of image $\mathbf{Z}^{(2)}$ corresponding to $z_i^{(1)}$, m_i – mean value of intensities in $\mathbf{Z}^{(2)}$ corresponding to $z_i^{(1)}$. For instance, if intensity values change from 0 to 256 than dispersion can be estimated as follows

$$D^2 = \frac{1}{\mu} \sum_{i=0}^{255} n_i \sigma_i.$$

Therefore, correlation ratio can be defined using the following equation:

$$\eta = \sqrt{1 - D^2}.$$

If the unique mapping transformation exists D is equal to 0 and η becomes 1.

Correlation ratio is highly efficient measure if images are corrupted with a significant intensity distortion both linear and non-linear.

Computational complexity of this measure is on the order of 256μ .

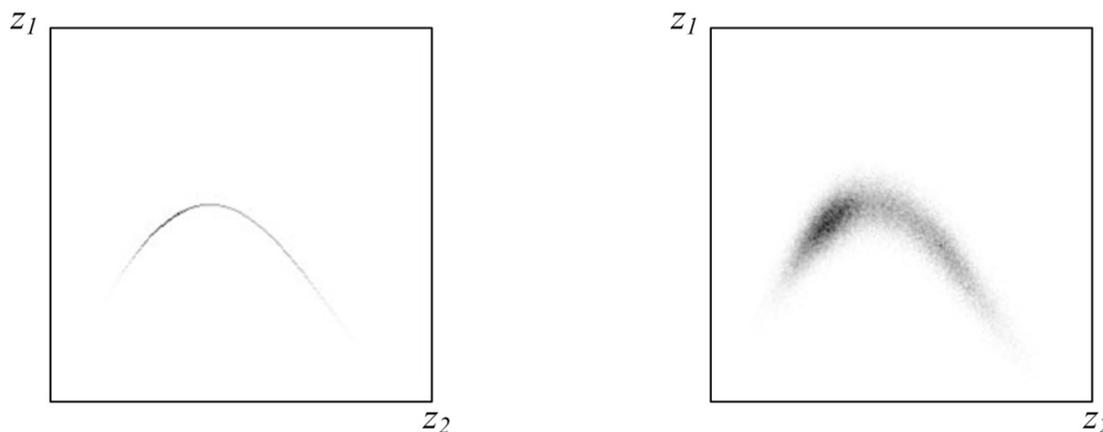
Energy of joint probability distributions

The relationship between images is reflected in their joint probability distribution (JPD) of intensity values. If there is a unique transformation between intensity values of a pair of images the JPD will look like a thin curve (fig. 1, a). If there is a geometric transformation between images than there is no more unique single-valued transformation between image intensities and a scatter appears in the JPD (fig. 1, b). The value of this scatter can be used as a similarity measure between images.

To estimate the value of this scatter we can use the JPD energy [22]:

$$E = \sum_{i=0}^{255} \sum_{j=0}^{255} p_{i,j}^2,$$

where $p_{i,j}$ – an element in JPD that can be estimated, e.g. using histograms. The higher the JPD energy the “closer” images are.



a) without geometric transformations b) with geometric transformations

Fig. 1. JPD of images

Energy of JPD is efficient even when the difference in intensity levels is significant and therefore it can be used for multimodal image registration. However, this measure is not robust to noise.

The computation of JPD requires μ operations and computation of its energy – 256^2 multiplications. Thus, the computational complexity of this measure depends linearly on the number of pixels in the images.

Shannon mutual information

Mutual information is one more measure that uses JPD of images. Collignon [23], Studholm [24], Viola [25], Maes [26] first started to use mutual information in image registration. As a similarity measure mutual information was first proposed by Shannon [27] and after generalized by Gel'fand and Yaglom [28]. Generalized mutual information in terms of entropy is defined as [29, 30]:

$$S_{MI} = H(\tilde{\mathbf{Z}}^{(1)}) + H(\mathbf{Z}^{(2)}) - H(\tilde{\mathbf{Z}}^{(1)}, \mathbf{Z}^{(2)}),$$

where $H(\mathbf{Z}) = -\sum_i p_z(z_i) \log p_z(z_i)$ – image entropy estimation, p_z – marginal probability distribution estimation of the image sample, $H(\tilde{\mathbf{Z}}^{(1)}, \mathbf{Z}^{(2)}) = -\sum_i \sum_k p_{z1,z2}(z_i, z_k) \log p_{z1,z2}(z_i, z_k)$ – joint entropy estimation, $p_{z1,z2}$ – joint probability distribution estimation.

Shannon mutual information is one of the most widely used similarity measure in image registration as it provides an extremely high accuracy when images have linear and non-linear intensity distortions, occlusions and also in case of additive noise and multimodal images.

Computational complexity of this measure is on the order of $256^2 + \mu$.

Renyi mutual information

Renyi mutual information is defined in terms of Renyi entropy. Renyi entropy of order α is defined by [31]

$$H_\alpha = \frac{1}{1-\alpha} \log_2 \sum_{i=0}^{255} p_i^\alpha.$$

When $\alpha=1$ Renyi entropy approaches Shannon entropy [32]. Moreover, when α is changing Renyi entropy varies between $\log_2 p_{\max} \leq H_\alpha \leq \log_2 256$, where

$p_{\max} = \max_{i=0}^{255} (p_i)$ [32, 33]. Renyi mutual information is calculated using the following equation [34]

$$R_{\alpha} = \frac{H_{\alpha}(\tilde{Z}^{(1)}) + H_{\alpha}(\mathbf{Z}^{(2)})}{H_{\alpha}(\tilde{Z}^{(1)}, \mathbf{Z}^{(2)})}$$

where $H_{\alpha}(\mathbf{Z})$, $H_{\alpha}(\tilde{Z}^{(1)}, \mathbf{Z}^{(2)})$ – Renyi entropies of order α .

When α is increasing Renyi mutual information increases too and the impact of outliers decreases. This makes Renyi mutual information more robust to noise in comparison with Shannon mutual information. But the cost of this efficiency is 20-30 % higher computational complexity which complicates its implementation.

Tsallis mutual information

Using Tsallis entropy in mutual information calculation leads to another similarity measure called Tsallis mutual information [35]. Tsallis entropy of order q is calculated by [36]

$$S_q = -\frac{1}{q-1} \sum_{i=0}^{255} p_i (1 - p_i^{q-1})$$

where q is a real number and as it approaches 1 Tsallis entropy approaches Shannon entropy. Tsallis mutual information can be found as follows [35, 36]

$$R_q = S_q(\tilde{Z}^{(1)}) + S_q(\mathbf{Z}^{(2)}) + (1-q) S_q(\tilde{Z}^{(1)}, \mathbf{Z}^{(2)}) - S_q(\tilde{Z}^{(1)}, \mathbf{Z}^{(2)}),$$

where $S_q(\tilde{Z}^{(1)}, \mathbf{Z}^{(2)}) = \frac{1}{q-1} \left(1 - \sum_{i=0}^{255} \sum_{j=0}^{255} p_{i,j}^q \right)$.

Using Tsallis mutual information with $q > 1$ leads to a better robustness to outliers in comparison with Renyi mutual information due to logarithm in the equation. Thus, Tsallis mutual information is more robust to noise.

This measure requires approximately the same number of arithmetic operation as Renyi mutual information.

F-information measures

The divergence or distance between joint probability distributions and multiplication of marginal distribution of image pair can be used as their similarity measure. A class of divergence measures that uses mutual information is the f -information or f -divergence. F -information measures are defined as follows [37, 38]

$$I_{\alpha} = \frac{1}{\alpha(\alpha-1)} \left(\sum_{i=0}^{255} \sum_{j=0}^{255} \frac{p_{i,j}^{\alpha}}{(p_i p_j)^{\alpha-1}} - 1 \right)$$

$$M_{\alpha} = \sum_{i=0}^{255} \sum_{j=0}^{255} \left| p_{i,j}^{\alpha} - (p_i p_j)^{\alpha} \right|^{\frac{1}{\alpha}}$$

$$\chi_{\alpha} = \sum_{i=0}^{255} \sum_{j=0}^{255} \frac{|p_{i,j} - p_i p_j|^{\alpha}}{(p_i p_j)^{\alpha-1}}$$

I_{α} measure is defined for $\alpha \neq 0$, $\alpha \neq 1$ and it approaches Shannon mutual information when $\alpha = 1$ [38]. M_{α} is defined for $0 \leq \alpha \leq 1$ and χ_{α} – for $\alpha > 1$.

These measures provide better accuracy of image registration in comparison with Shannon mutual information [37]. However, in terms of computational complexity they are way more complicated.

2 Dissimilarity measures

In contrast to similarity measures dissimilarity measures have minimum values when images are perfectly aligned.

Mean of absolute differences

Mean of absolute differences is one of the oldest dissimilarity measures used to estimate spatial deformations. It can be calculated using very simple equation [12]:

$$L_1 = \frac{\sum_{\bar{j}_t \in \Omega_t} |\tilde{z}_{\bar{j}_t}^{(1)} - z_{\bar{j}_t}^{(2)}|}{\mu}.$$

If images are received by the same sensors under the same conditions and images have considerably high signal-to-noise ratio, this measure usually produces as accurate results as those produced by more computationally complex measures. Mean of absolute differences is quite effective in a video or stereo image matching when noise level is low. However, as the noise level increases the results becomes significantly worse.

Computationally, this measure requires μ operations of difference absolute value calculation and μ additions.

Median of absolute differences

In case of pulse noise mean of absolute differences becomes ineffective and produces large errors. To decrease noise influence instead of mean value the median of absolute differences can be used

$$MAD = \text{med}_{\bar{j}_t \in \Omega} |\tilde{z}_{\bar{j}_t}^{(1)} - z_{\bar{j}_t}^{(2)}|.$$

Even though noise changes the absolute value of the differences it does not change a lot the median value.

This measure is quite effective in registration of images with occlusion, e.g. in stereo vision. The median of absolute differences was examined in [39, 40]. In [41, 42] the effectiveness of this measure in case of about 50 % of outliers is shown.

MAD calculation includes computation of corresponding pixel values differences, their ranking and searching for the median value. Thus this measure is way more slowly than the previous one. The ranking calculation requires about $\mu \log_2 \mu$ operations.

Mean squared difference

Mean squared difference is one of the most simple dissimilarity measures.

It is defined as follows

$$L_2 = \frac{\sum_{\bar{j}_t \in \Omega_t} (\tilde{z}_{\bar{j}_t}^{(1)} - z_{\bar{j}_t}^{(2)})^2}{\mu}.$$

Mean squared difference is the optimal measure in registration of images corrupted only with additive Gaussian noise [9, 10]. As all the previous dissimilarity measures mean squared difference is not robust in case of non-linear intensity distortions or large occlusions.

Computational complexity of this measure is the same as for the mean of absolute difference.

Median of squared differences

Median of squared differences is less sensitive to additive noise than mean squared difference. This measure is calculated by the following equation

$$MSD = \text{med}_{\tilde{j}_i \in \Omega_i} \left(\tilde{z}_{\tilde{j}_i}^{(1)} - z_{\tilde{j}_i}^{(2)} \right)^2.$$

However, if images are not corrupted with noise mean squared difference becomes more effective than MSD due to the fact that MSD uses information only about the most similar pixels.

Computationally, median of squared differences requires additional intensity ranking that needs about $\mu \log_2 \mu$ operations.

Normalized mean squared difference

When calculating correlation coefficient, intensity values are normalized with respect to mean value. This normalization increases the registration efficiency in case of linear intensity distortions. Besides, correlation coefficient is normalized with respect to standard deviation of intensities. This normalization can be considered as normalization with respect to image contrast. In [43] a contrast normalization method when calculating mean squared difference was proposed. It consists in dividing normalized with respect to mean value intensities by their standard deviation before the subtraction:

$$NL_2 = \frac{\sum_{\tilde{j}_i \in \Omega_i} \left(\frac{\tilde{z}_{\tilde{j}_i}^{(1)} - M[\tilde{Z}^{(1)}]}{\hat{\sigma}_{z_1}} - \frac{z_{\tilde{j}_i}^{(2)} - M[Z^{(2)}]}{\hat{\sigma}_{z_2}} \right)^2}{\mu}.$$

Similar to correlation coefficient this measure is quite effective in registration of images with linear intensity distortions, e.g. when images are taken under different lighting conditions.

In terms of computational time this measure is a bit slowly than correlation coefficient is it requires normalization of each intensity value before squared difference calculation.

Incremental sign distance

Let us denote the binary array consisting of signs of differences between the previous and the next pixels as \mathbf{B} . Additionally, let $b_i = 1$ if $z_{i+1} > z_i$ and $b_i = 0$ otherwise. Than Hamming distance between these binary arrays can be used as a dissimilarity measure [44].

The use of intensity change instead of their values leads to more accurate result in registration of images with additive noise. Furthermore, the use of sign change instead of intensity change produces better results in case of stepwise intensity changes. However, this measure is not robust in registration of images with non-linear intensity distortions or occlusions. Another drawback of incremental sign distance is a large registration error when images have big regions with constant intensity value.

This dissimilarity measure is quite effective in terms of computational

complexity as it requires just about μ comparisons, additions and subtractions.

Intensity ratio variance

If intensities in one image are equal to intensities in another image up to a constant, the ratio of corresponding intensities will be a constant. This dissimilarity measure can be effective if images are taken at different camera exposures. Letting $r_i = (z_i^{(1)} + \varepsilon) / (z_i^{(2)} + \varepsilon)$, where ε – a small number added to avoid division by 0, intensity ratio variance is defined as follows [45]:

$$R_v = \frac{1}{\mu} \sum_{i \in \mu} (r_i - \bar{r})^2,$$

where $\bar{r} = \frac{1}{\mu} \sum_{i \in \mu} r_i$.

Although this measure is effective when intensities are multiplied by a scalar, it produces significant errors in case of additive noise. Computationally, it requires a number of operations on the order of μ .

Intensity mapping ratio variance

This measure combines correlation ratio estimating intensity mapping variance and intensity ratio variance [46]. It consists in using intensity ratios instead of intensity values when calculating correlation ratio. This helps to cope with intensity multiplication and differences in exposure levels.

This measure is a bit more complex in terms of computational complexity as it requires additional intensity ratio calculation.

Average rank distance

Average rank distance is defined as an average absolute value of differences between corresponding pixel intensity ranks:

$$D_r = \frac{1}{\mu} \sum_{j_i \in \Omega_i} |P(z_{j_i}^{(1)}) - P(z_{j_i}^{(2)})|.$$

As an intensity rank is a positive value not greater than μ , this measure takes on values between 0 and 1. Average rank distance produces accurate results in registration of images with linear intensity distortions, additive noise and occlusions. Moreover, it is quite robust in case of white noise if it does not change intensity ranks a lot.

Average rank distance is one of the fastest measures among ordinal measures because it requires only one subtraction and sign determination for every pixel besides one ranking for the whole sample that is the most complex and requires about $\mu \log_2 \mu$ operations.

Entropy of joint probability distribution

Entropy determines the uncertainty of a data. The bigger entropy the more information required. Entropy of joint probability distribution shows the uncertainty of the JPD. The stronger the relationship between two variables the smaller the entropy of JPD. This measure is defined in terms of Shannon entropy [27, 47]:

$$H(\tilde{\mathbf{Z}}^{(1)}, \mathbf{Z}^{(2)}) = - \sum_{i=0}^{255} \sum_{j=0}^{255} p_{i,j} \log_2 p_{i,j}.$$

This dissimilarity measure is effective in multimodal image registration and in registration of images with linear and non-linear intensity distortions. However, it produces a bit less accurate results than Shannon mutual information and this measure is more sensitive to noise.

Computational complexity of entropy of JPD is proportional to 256^2 and μ . It requires about μ comparisons for JPD estimation and about 256^2 multiplications and logarithm calculations for entropy estimation.

Exclusive f -information

Exclusive f -information is related to entropy of JPD and Shannon mutual information [48]:

$$D_f(\mathbf{Z}^{(1)}, \mathbf{Z}^{(2)}) = H(\tilde{\mathbf{Z}}^{(1)}, \mathbf{Z}^{(2)}) - S_{MI}(\tilde{\mathbf{Z}}^{(1)}, \mathbf{Z}^{(2)}).$$

As Shannon mutual information can be defined as follows [37]:

$$S_{MI}(\mathbf{Z}^{(1)}, \mathbf{Z}^{(2)}) = H(\tilde{\mathbf{Z}}^{(1)}) + H(\mathbf{Z}^{(2)}) - H(\tilde{\mathbf{Z}}^{(1)}, \mathbf{Z}^{(2)}),$$

we obtain the following

$$D_f(\tilde{\mathbf{Z}}^{(1)}, \mathbf{Z}^{(2)}) = 2H(\tilde{\mathbf{Z}}^{(1)}, \mathbf{Z}^{(2)}) - H(\tilde{\mathbf{Z}}^{(1)}) - H(\mathbf{Z}^{(2)}).$$

Exclusive f -information is a bit less effective than Shannon mutual information and computationally it is slower [8].

Criteria for objective function effectiveness analysis

Let us consider an example of effectiveness analysis in noisy conditions of three widely used objective functions: Shannon mutual information (MI), correlation coefficient (CC) and mean square difference (MSD). To investigate the influence of noise on the objective functions it is reasonable to use simulated images because we can first define the probability density function of the intensities and the correlation function. Simulated images with close to Gaussian probability density functions of intensity and with a correlation function close to Gaussian were synthesized based on a wave model. Experiments were performed with a noise-to-signal ratio q from 0 to 2 ($q = \text{noise variance} / \text{signal variance}$). Fig. 2 shows the dependence of the objective functions from translation h and noise with different variances ($q=0.002$, $q=0.02$, $q=0.2$, $q=2$). Hereafter curve 1 is MSD, 2 – CC, 3 – MI. One can see that in case of weak noise ($q=0.002$) MI has the maximum slope. When using recurrent algorithms this fact can lead to a better convergence of the estimates of interframe geometric deformations. Moreover, due to the greatest sharpness, the use of MI can provide more accurate estimates (the problem of computational cost is not considered in this work). However, when the level of noise increases the slope and sharpness of MI's characteristic decrease. When q changes from 0 to 2, the maximum of the MI's characteristics decreases 15 times. The MSD-curve behaves according to the theory (this function can be found analytically if the correlation function and noise-to-signal ratio are given). The slope of the MSD-curve gradually decreases and the minimum increases from 0 to 0.52 (when $q=2$) with an increasing noise level. The CC-curve behaves approximately the same, except for the fact that it has a maximum (not minimum) decreasing from 1 to 0.55.

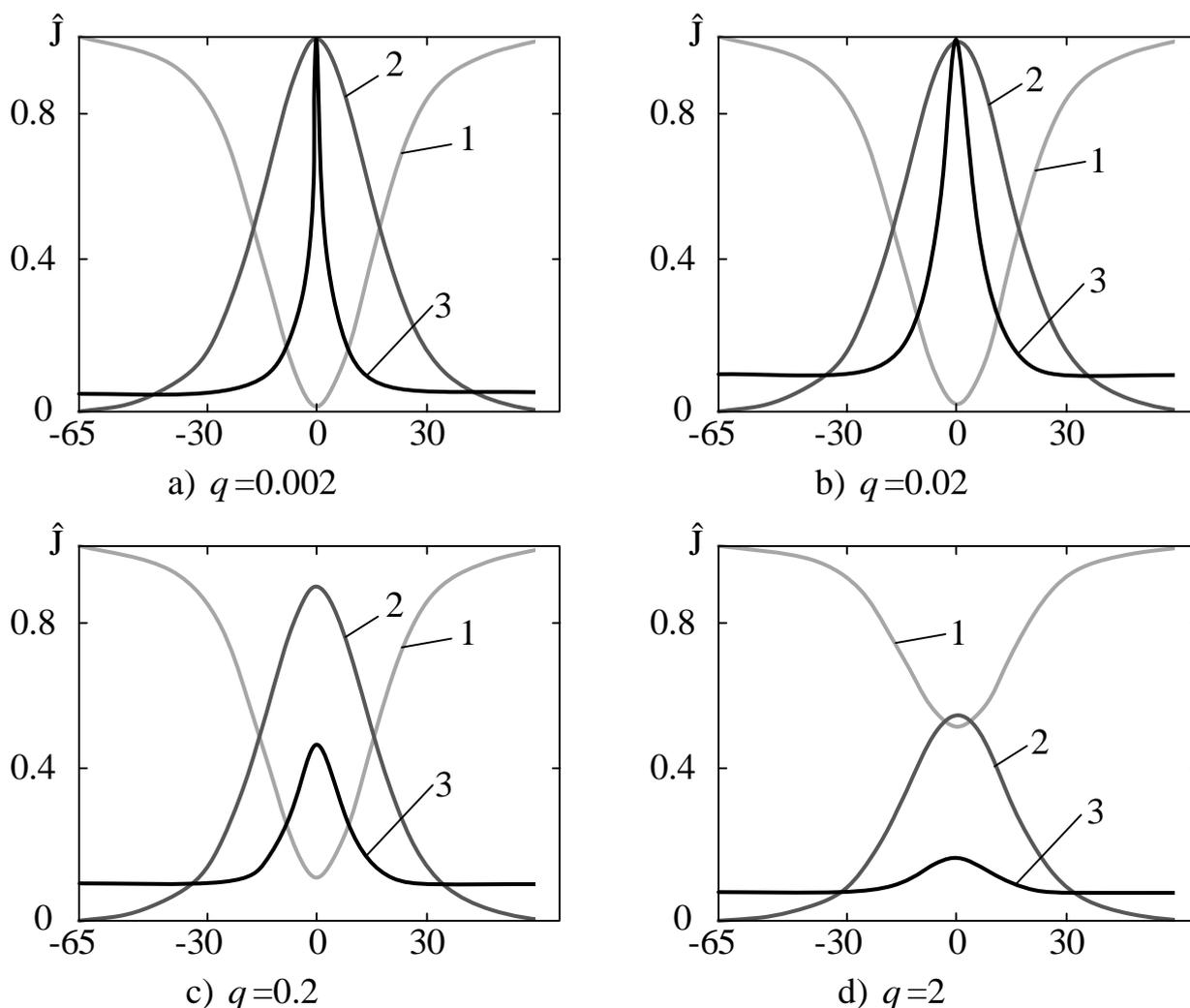


Fig. 2. Estimation of objective functions for different noise-to-signal ratios

Fig. 3 shows the dependence of the maximum slope (K) of the MSD, CC and MI curves on q . One can see that when the noise level is low the MI-curve has a significantly higher slope in comparison to MSD and CC. However, when the noise becomes stronger (approximately when $q=0.1$) MI starts to show poorer results than MSD and CC. The maximum slope of the MSD-curve smoothly decreases by 1.6 times, and the CC-curve 1.4 times, as q increases from 0 to 2. Thus, when images differ by additive noise and $q > 0.1$, the use of MI may potentially not provide a better convergence of recurrent algorithms used to estimate the interframe geometric deformations.

Effective range is another important measure of estimation procedures. It is a subdomain of parameters in which estimates of interframe geometric deformations have a required accuracy with given constraints (e.g. computational cost, number of iterations, etc.). One of the criteria for including a point in this subdomain is the slope of the objective function's curve at this point. The slope needs to exceed a threshold – a value which cannot provide the required convergence of the estimates' vector \mathbf{a} . To measure this parameter for the investigated objective functions, a conventional threshold was assumed.

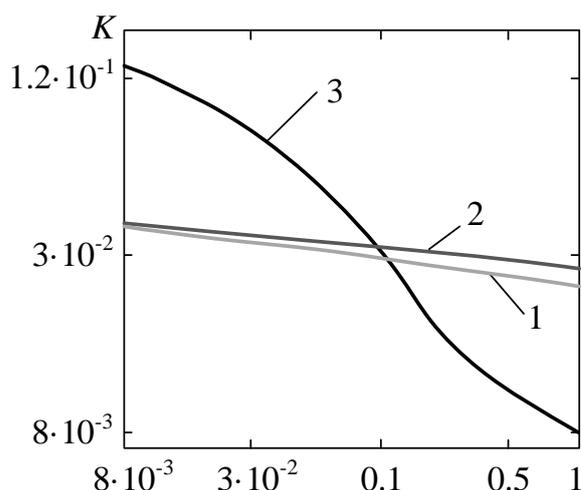


Fig. 3. Maximum slope.

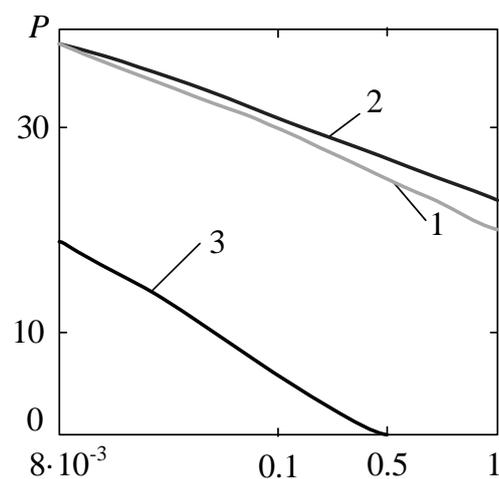


Fig. 4. Potential effective range

Potential effective range P of recurrent estimation procedures was estimated using this threshold (actual effective range depends on the procedure's performance, type of deformations, etc.). Fig. 4 shows the dependence of the potential effective range on q in the case where the threshold is equal to 0.035. One can see that MI presents results that are two times worse than MSD and CC. Without noise, MSD and CC have equal P . The effective range of CC decreases by 1.7 times by increasing q to 1, for MSD – by 1.9 times. MI only has non-zero effective range when $q \leq 0.5$.

Conclusion.

Similarity measures (correlation ratio, energy of JPD, Shannon, Renyi and Tsallis mutual information, ordinal measure, correlation coefficient, Tanimoto coefficient, Spearman and Kendall correlation coefficients, greatest deviation) and dissimilarity measures (mean of absolute and squared differences, median of absolute and squared differences, normalized mean squared difference, incremental sign distance, intensity mapping variance, average sign distance, entropy of JPD, exclusive f -information) are analyzed in terms of image registration problem. Maximum slope and potential effective range were considered as criteria for objective function effectiveness analysis. In conclusion, we can say that the process of choosing an objective function is quite difficult because there is no perfect measure for every conditions and for each image class.

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Vanin V.V., Gryaznova G.P., Dopira G.G., Lazarchuk M.V.
SOME ASPECTS OF STRUCTURAL-PARAMETRIC APPROACH FOR
THE MODELLING OF COMPOSITE PARTS PRODUCTION
TECHNOLOGY

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Abstract. According to the key tasks of modern production and the spreading tendency of using of composite materials the structural-parametric approach was offered in order to optimize the technological process of machinery parts production. This method is directed to improve such characteristics of production as energy and human workforce resources and the others.

Keywords: composite materials, computer information technologies, structural-parametric geometric modelling.

1. Introduction. Modern engineering requires the development of structural materials that meets the requirements of durability, reliability, sustainability and the other operating parameters, and reduces the weight of the product. The use of composite materials (CM) is one of the solutions to this problem [1-3]. Research and development of composites belong to the section of the science of structural materials having intensive development. Modular technology makes it possible to extend the development of research results to a wide range of products.

2. Materials and methods of research. Research and development of modular technology based on computer structural and parametric geometric modeling [4,5] is the basis for the optimization of the process of creation of technical products from composite materials.

Consider the common principles of structural-parametric geometric modeling for the machine-building part. First, we have to create the structural model based on the list of constructing details of the part, for example, the set of its surfaces.

$$\Pi = (3\Pi, B\Pi, CE)_1^{N_n}, \quad (1)$$

where N_n – the total quantity of surfaces, made of composite materials, 3Π , $B\Pi$ and CE – respectively the quantity of outward, inner surfaces and the surfaces of separate standard elements, which are calculated by formulas:

$$3\Pi = (3\Pi_i)_1^{N_{3\Pi}} \quad (2)$$

$$B\Pi = (B\Pi_i)_1^{N_{B\Pi}} \quad (3)$$

$$CE = (CE_i)_1^{N_{CE}} \quad (4)$$

Standard elements (CE) are united to a special group, because they have a complicated geometric shape. On the other hand they are placed usually denoted conventionally or simplified on the drawings (e.g. center holes, etc.). CE are produced and processed separately, and thus are related to particular $3\Pi_i$ or $B\Pi_i$.

The final combination of 3Π and $B\Pi$ in connection with possible CE come to the adjacency surfaces matrix. Sequence of parts combination must also be taken into account. The simplest part, which has only one 3Π of all the possible combinations of arbitrary parts, composed as follows:

$$\Pi_1 = (\Pi_{ii})_1^{N_{\Pi}}, \tag{5}$$

where N_{Π} - the number of options.

Considering a geometric grouping of surfaces that affects the method of manufacture and reinforcement scheme, the following separation can be possible:

$$\Pi_1 = (\Pi_{ii\sigma})_1^{N_{\Pi\sigma}} + (\Pi_{ii\sigma})_1^{N_{\Pi\sigma}}, \tag{6}$$

where $\Pi_{ii\sigma}$ and $\Pi_{ii\sigma}$ - respectively the number of surfaces of revolution and the ones of more complicated shape.

Consider the example of a parametric model of the manufacturing pipeline made by winding of carbon composites (Figure 1).

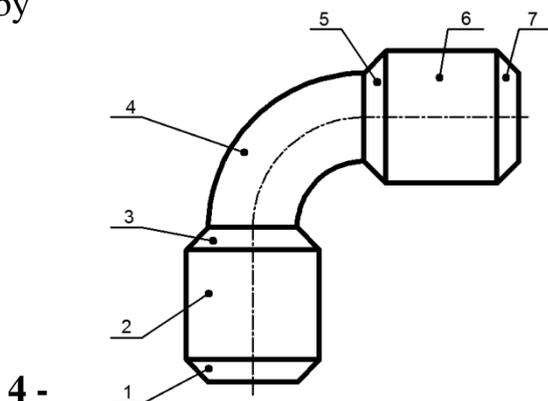


Figure 1. Compression removal part made of carbon composites. 1, 3, 5, 7 - conical chamfers, 2, 6 - cylindrical surfaces, part of Torus surface.

In the first stage we define the vector of parameters of technological process of the part production.

$$P_{om6} = f_1, f_2, f_3, f_4, f_5, f_6, f_7, m_p, g_1, g_2, g_3, g_4, g_5, g_6, g_7, \tag{7}$$

$$m_{кл.}, s_{ch}, v_{HAM}, f_{onp}, t, sum, h_{cmp},$$

where f_i ($i = 1..7$) - form the corresponding surface; m_p - material type; g_i , ($i = 1..7$) - the strength of the surface; v_{HAM} - method of winding; s_{ch} - winding scheme; $m_{кл.}$ - sort of adhesive; f_{onp} - form of mandrel; t - temperature of material cure; sum - the method of combination of composite and adhesive; h_{ctp} - the tape width. In general, formula (1) looks as follows:

$$P_i = (P_j)_1^{N_{pi}}, \tag{8}$$

where N_{pi} - number of used parameters. In this example, N_{pi} is 22.

In the next step we determine the parameters of a fixed value. It should be noted that the geometrical parameters f_i are also consist of several sub-groups, for example, the conic surface 1 [10] (Fig. 1) includes the diameter of the upper base - d_B , lower base - d_H and the height of the cone - h_K .

The cylindrical surfaces 2 and 6 include height h_{ii} and diameter of the bottom h_{ii} . For torus surface 4 parameters are the diameter of the smaller circle of derivative- d_{MK} , the bigger one - $d_{\sigma K}$ and the angle between two sections - γ . Thus, the total number of parameters is turned to be 41.

Further we define the parameters with the constant output value and come to the vector of varying parameters with 29 degrees of freedom. For the parameters of variation it should have the following values that minimize the deviation Δ , according to the criteria and using one of the following methods: sum of squares minimum, sum of deviations modules minimum or maximum in modulus deviation minimum.

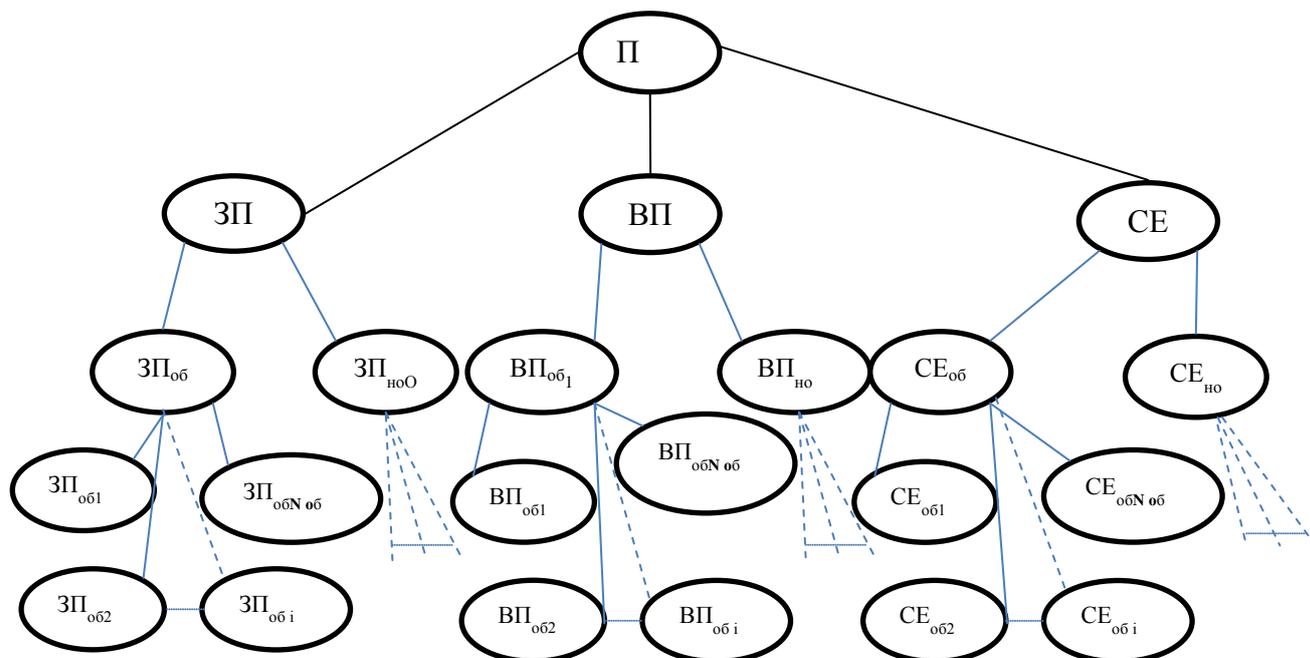


Figure 2. General view of the structural model of a part.

In general, the calculations using numerical methods for the process of finding the optimum value must be limited to the define values for each variable. Considering the division of all surfaces on the basis of the complexity of each surface form (Formula (6)), the general graph structure of any part looks like the one shown in Figure 2, where «П» means all the surfaces, index "об" means surfaces of revolution and "но" - all the other surfaces.

Conclusions. Taking into account the mentioned above and other characteristics of the technological process, such as the type of polymer, used reinforcement adhesive material type, equipment, etc., it can be concluded that the production process depends on many interrelated parameters. Some of these parameters, which are the output arguments, define other values that are functions.

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FORMING THE TABLES OF ACCURACY, ADAPTED FOR TECHNOLOGICAL CAPABILITIES OF METALWORKING PRODUCTION

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Abstract. It is shown that one of the reasons for ambiguity technological route design is a discrepancy between the recommendations of standard reference publications, and technological capabilities of production for which the designing. Proposed as information support of technological design to use tables accuracy, which formed taking into account the capabilities of real production. Is seen the approach to the construction of tables accuracy, adapted to the capabilities of the enterprise.

Key words: route design, generalized tables accuracy, manufacturing capability, technological tolerance of processing method.

One of the problems of modern technology engineering and, in particular, automation of technological design is ambiguity [3, 10] reference data used when forming a routing technologies. Analyzing [3, 10] the table accuracy of machining, we assume that the quality of processing, is a complex index matching processing results and requirements for the product, there is a technological concept, that characterize each of the methods of machining. If the result of the process is estimated by homogeneous [6] random variable, then the process and the corresponding reference data are reliable, therefore, the results of the design can also be considered reliable. Uniformity (reliability) of the reference data, relating to machining processes, we propose to estimate [5, 10] with the variation coefficient [6].

Another, in our view, very significant, problem of modern engineering, is the incompatibility of recommendations reference literature with technological possibilities of real production. We have conducted a comparative analysis [7, 9], generalized reference data [1, 10] with requirements specified in the technical documentation for a particular product and results of production of these products in relation to the parameter precision, as measured by the IT number. Fragments of data that can be compared are given in table 1.

Table 1.

Providing accuracy machining

Способ обработки	Reference data		Data of real production	
	exactly	roughly	exactly	roughly
Finish boring	7	10	8	10
Finish turning	9	11	10	11
Fine turning	5	7	8	9
Semi grinding	8	10	11	
Finish grinding	7	8	9	11

Note, that reference recommendations can be tightened against the "left" (exact) borders – finish turning and boring, – with overlap between the fields of

technological tolerances.

Equally, it is possible to speak about the complete mismatch of the recommendations of reference books with the possibilities of real production – fine turning and grinding. As reasons for this discrepancy can be called not only the stochastic nature of the methods of machining, but the actual technical condition of the cutting equipment, the actual status and physical-mechanical properties of the cutting tool and the workpiece material, and many others [8].

We talk about the need to adapt the reference data to the specific production, not refuting the generally accepted views on the principles of technological design. This is due to the fact that the real technological capabilities of each machine building enterprise differ from the average values of technological tolerances, which given in the reference data.

We offer the following approach to build information files containing recommendations on the choice of processing methods to the particular circumstances of the production:

1. in accordance with conventional methods, we find average values of technological parameters of accuracy achievable on each specific piece of equipment - averaging takes into consideration all of the products processed on this equipment, the interval of variation technological accuracy rate is displayed in the data array (fig. 1) as a characteristic of certain technological transition that is performed on the *i*-th piece of equipment;

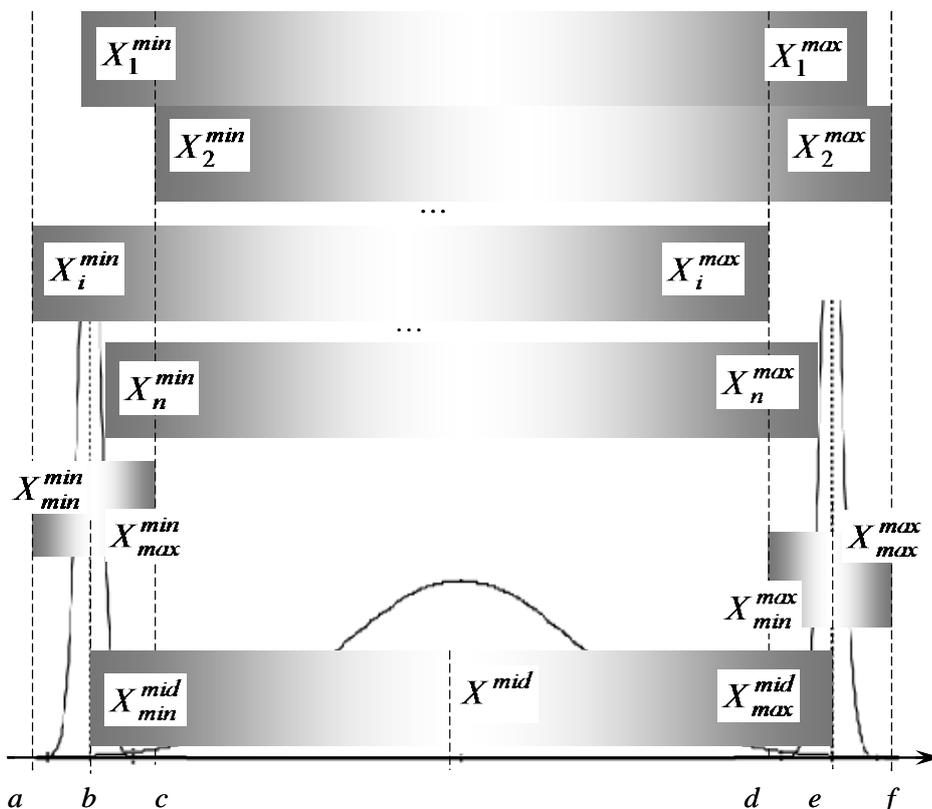


Fig. 1 Design scheme to define the boundaries of the ranges of process indicator

2. in accordance with the methods of generalization of [1, 8, 10] data, we calculated the values of the field boundaries of technological tolerances for a particular technological transition.

The technique of generalized involves consideration of the technological parameters of accuracy and quality as interval data. In particular, the interval of variation of the values of technological indicator is represented by a set of overlapping intervals of variation of independent random variables:

– the left boundary of the interval is a random variable $X_{min} \in [X_{min}^{min}; X_{min}^{max}]$ with a mean X_{min}^{mid} , standard deviation S_{min} and probability density $F^{min}(x)$;

– the right boundary of the interval is a random variable $X_{max} \in [X_{max}^{min}; X_{max}^{max}]$ with a mean X_{max}^{mid} , standard deviation S_{max} and probability density $F^{max}(x)$.

Each marginal random variables and can be considered as a joint and independent [5, 8] concerning technological measure, which is also a random variable $X^{mid} \in [X_{min}^{mid}; X_{max}^{mid}]$ with a mean X^{mid} , standard deviation S and probability density $F^{mid}(x)$. Change ranges are computed in accordance with the method [3]. Statistical characteristics of each of the random variables are determined depending on the width of the corresponding interval variation and the type of distribution the probability density of the random variable in the corresponding interval.

Analysis [3] the behavior of random variables in the surrounding area (fig. 1) boundaries of the considered interval – ranges [a, c] and [d, f], – showed that the total probability is different from the probability by several orders of magnitude, regardless of the distribution function.

Thus, as the technological tolerance of processing we can consider the interval [b, e]. As the distribution function of a random variable we can be viewed Gauss's function, because in this case the statistical forecast is pessimistic, i.e., the calculated value the integral of the probability is the lowest, compared to, for example, with the Simpson's or uniform distribution.

To verify the correctness of the considered approach, we have created a generalized tables accuracy of processing methods to external cylindrical surfaces:

1. according to the most commonly used technological directories listed in our works, for example [3, 5, 8, 10];

2. with the experimental data, obtained in process inspection of any machine-building enterprises.

On the basis of the generalized tables were constructed probabilistic tables accuracy [8] and were made the formalized route design [2]. Comparing the created technologies with technological processes of the enterprise showed significantly higher convergence results for design based on the production tables accuracy.

Conclusion: an efficient and robust process design is possible, when using the tables, which adapted to the technological capabilities of the enterprise, as reference data.

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Tchigirinsky Ju. L., Trong Ngo Quang
PROBABILISTIC TABLES accuracy MILLING planes

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Abstract. It is shown that one of the reasons of low efficiency of technological preparation of production is the lack of formal mathematical methods for solving routing design, associated with the ambiguity of the reference data and incomplete logical structure information arrays. Proposed to use probabilistic accuracy tables as information support of technological design.

Key words: formalized route designing, manufacturing tolerances, generalized tables accuracy, probability tables accuracy, reliability plan of processing.

In this paper we continue the discussion the problems of formalized design routing process related to heterogeneity and low reliability of reference data. As an example, consider the design of a planes of machining flat surfaces with face and cylindrical cutters.

Machining accuracy as measured by the number of degree of accuracy (IT), the quality of the processed surface is the value of the arithmetic mean deviation of profile Ra. In accordance with the previously formulated assumptions [9, 15], parameter precision is a discrete, and the quality parameter - continuous - random value. Data for statistical analysis [9, 13, 15] is taken from the following[11, 2, 3, 5, 6, 7, 8, 18] publications:

Previously [13] we proved the thesis of partial inapplicability methods of theory of sets for the analysis of information of technological handbooks. In table 1 and at fig. 1 shows a generalized, taking into account the probabilistic of membership function [4, 13], data on the value of the arithmetic mean deviation of profile Ra and parameter accuracy IT for navigation milling.

Data reliability is measured by the coefficient of variation [9]. In the columns "%" are given probabilistic reliability assessment of the generalization process tolerance. Note that, the value of the "100,00" we denote the probability values, insignificant - not more than 10^{-5} , is different from the unit.

Table 1. Globalized technological tolerances for milling

	<i>Ra, mcm</i>				<i>IT</i>			
	min	max	mid	%	min	max	mid	%
milling with cylindrical cutters								
roughing	10,40	27,14	18,77	99,997	11,86	13,71	12,76	100,00
finishing	1,73	4,79	3,26	99,982	9,71	11,86	10,79	100,00
fine	0,71	1,54	1,13	99,999	6,83	8,50	7,67	100,00
milling with face cutters								
roughing	5,69	19,00	12,35	99,874	11,71	13,71	12,71	100,00
finishing	1,64	5,13	3,39	99,923	9,71	11,29	10,50	100,00
fine	0,51	1,40	0,96	99,981	6,83	8,50	7,67	100,00

Comparing the reference data with the boundaries of the generalized

technological tolerances built taking into account the probabilistic of membership function [13], we can conclude that the significant heterogeneity of the reference data on the basis of which built most typical technological processes – divergence values for generalized data reaches 15 %...22 % for surface quality and 12 %...18 % – for precision machining.

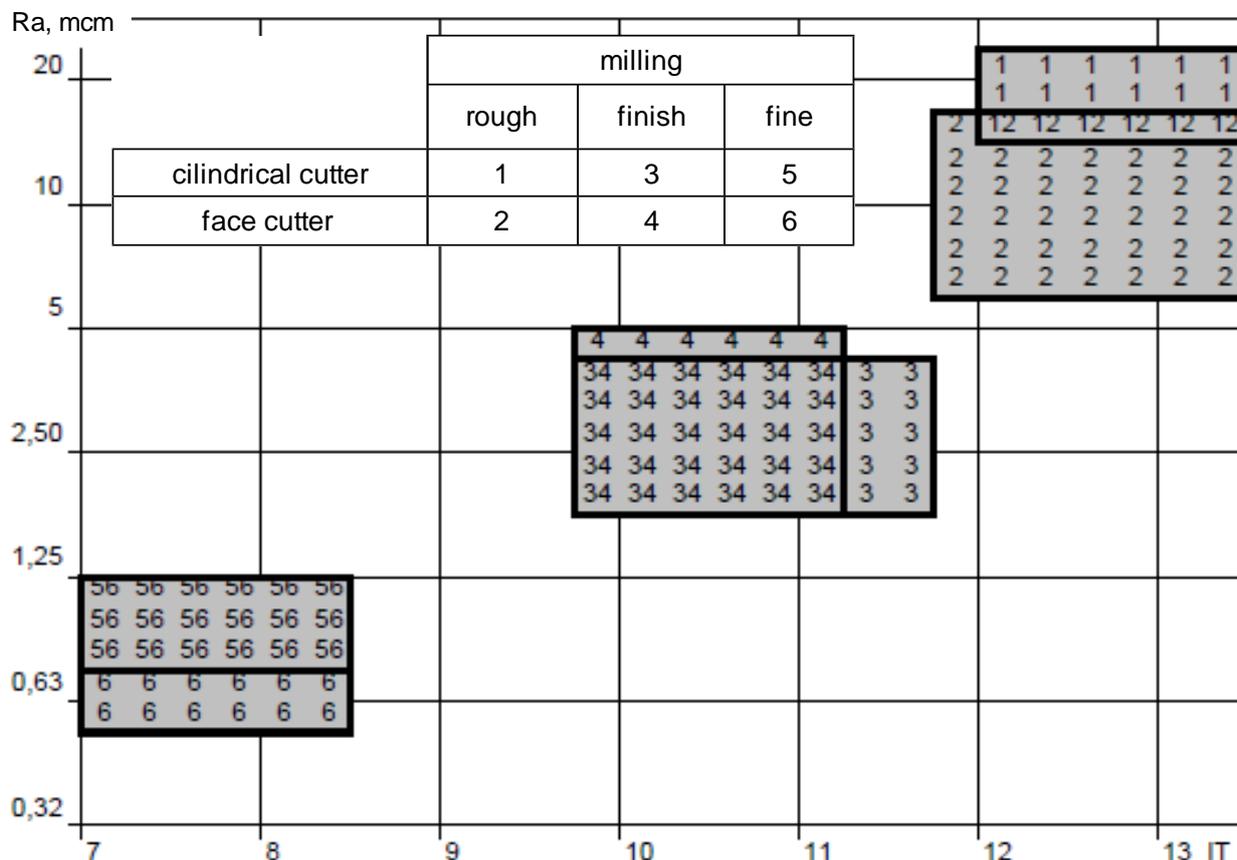


Fig. 2 Scheme of technological tolerances

The relative width of the field of technology admission indicator precision significantly (3...6 times) less than the same indicator parameter Ra, which can be considered as indirect confirmation of the expressed stochastic nature of the process of formation of the surface quality is more explicit, compared to the process of forming the dimensional accuracy of machined surfaces.

Problems formalized route design are defined [11, 12], in our opinion, two main reasons: low reliability of reference data and lack of data structures that can apply to solve problems of mathematical methods. The problem of insufficient reliability of the information arrays can be solved by constructing lookup tables, adapted to the technological capabilities of each specific production. As one of the possible solutions to the second problem, we propose using, as the logical structure of the reference data, so called, probabilistic table accuracy [17].

The structure of the probability tables accuracy (tab. 2) involves consideration of the technological possibilities for each adjacent pair in the technological sequence of processing methods. Above the main diagonal for each pair of adjacent process steps specified value of changes in technological measure the accuracy / quality of treatment. The magnitude of the change process indicator is defined as the difference

(for discrete) or ratio (for continuous random variables) averages of technological tolerances of two related, technological sequence processing methods.

Table 2.

Probabilistic table accuracy

Technological method		Process tolerance, Ra, mcm		Ra, multiplicity / reliability, %												
				Next stage												
		min	max	1		2		3		4		5		6		
mi n	ma x			mi n	ma x	mi n	ma x	mi n	ma x	mi n	ma x	mi n	ma x			
Preview stage	1	Rough cylindrical	10,40	27,14	X		1,4	1,8	5,7	6,0	5,3	6,3				
	2	Rough face	5,69	19,00	100,0		X		3,3	4	3,5	3,7				
	3	Finish cylindrical	1,73	4,79	100,0		100,0		X		0,9	1,1	2,4	3,1	3,4	3,4
	4	Finish face	1,64	5,13	100,0		100,0		100,0		X		2,3	3,3	3,2	3,7
	5	Fine cylindrical	0,71	1,54					100,0		100,0		X		1,1	1,4
	6	Fine face	0,51	1,40					100,0		100,0		100,0		X	
Technological method		Process tolerance, , IT		IT, difference / reliability, %												
				Next stage												
		min	max	1		2		3		4		5		6		
mi n	ma x			mi n	ma x	mi n	ma x	mi n	ma x	mi n	ma x	mi n	ma x			
Preview stage	1	Rough cylindrical	11,86	13,71	X		0,0	0,2	1,9	2,2	2,2	2,4				
	2	Rough face	11,71	13,71	99,73		X		1,9	2,0 0	2,0	2,4				
	3	Finish cylindrical	9,71	11,86	100,0		100,0		X		0,0	0,6	2,9	3,4	2,9	3,4
	4	Finish face	9,71	11,29	100,0		100,0		99,73		X		2,9	2,8	2,9	2,8
	5	Fine cylindrical	6,83	8,5					100,0		100,0		X		0,0	0,0
	6	Fine face	6,83	8,5					100,0		100,0		100,0		X	

Given the stochastic nature of the machining processes, it is necessary, in addition to calculating the actual value of changes in technological measure, evaluate and even reliability of this change. Below the main diagonal – probabilistic assessment of reliability (accuracy) of the index change calculated [10, 17] for the

coefficient of variation of the magnitude of the changes.

Related methods, for which negligible small value changes of the technological measure, or the validity of the changes that we believe are similar, i.e., forming the same properties of the treated surface. Thus, in each of the options plan, you receive a formal characteristic that determines the possibility and necessity of application of each pair of adjacent methods for surface treatment. If we consider a quantitative assessment of the reliability of the technological change index as the criterion optimization for search paths in the graph processing, the optimal design should consider the option plan, for which the higher the probability of obtaining the required accuracy metrics.

Conclusion: probability tables exactly allow for a formalized design treatment plans with regard to significant changes in indicators of quality and precision. This approach allows us to predict the results with the characteristics of each of the design options for treatment plans.

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Zhdanov A. A., Plotnikov A. L., Tchigirinsky Ju. L., Firsov I. V.
THE FORM'S TOLERANCE AS THE EQUIVALENT OF THE
DETAIL'S DEFLECTION VALUE IN THE SUBSYSTEM OF ENSURING OF
PRECISION OF NON-RIGID SHAFTS TURNING ON CNC MACHINES

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At present increase the practice of using the CNC machines. They allow making high-precision high-performance processing of details and to receive the difficult surfaces without using of special cutting tools. However the use of CNC machines in processing of non-rigid details isn't always justified because for execution of the precision's requirements often it is necessary to resort to installation of devices like lunettes, and also special methods of fixing. The processing of such detail for one part positioning is almost impossible. In such conditions the use of CNC machines is no rational for economic and technological reasons. So, for example, the precision when processing on CNC machines is in many respects provided due to processing of the maximum number of surfaces of a detail for one part positioning, that is without change of technological bases. Thus, traditional approaches to ensuring of precision of non-rigid details' turning don't allow using possibility of CNC machines rationally. However there are also alternative approaches, for example, the use of a subsystem of ensuring of precision of non-rigid details' turning with a program way at the expense of changing of submission in process of processing. In case of such approach it is necessary to have reliable estimated mathematical models.

For ensuring of precision of turning of details of low rigidness it is accepted to making calculation on accuracy and by its results to adjust the modes of processing or to change the methods of fixing. In a general view the calculation formula of the maximum sag of blank under the influence of the radial component force of cutting looks as follows [1]:

$$y_{\max} = \frac{P_y \cdot L_{\text{blank}}^3}{k_{ch} \cdot E \cdot J}, \quad (1)$$

where k_{ch} – the coefficient considering the influence of fixing method;

P_y – the radial component of force of cutting;

L_{blank} – the length of blank between fixing points;

E – the module of normal elasticity;

J – the inertia moment of the blank's section;

The further calculation usually consists in comparison of value of the estimated maximum blank's sag with the appropriate form tolerance which is specified on the drawing, or is determined by a formula [2]:

$$y_{\max} \leq [y]_i = k_i \cdot Td, \quad (2)$$

where $[y]_i$ – the form tolerance according to the accepted level of geometrical precision (A, B or C);

k_i – the coefficient considering the accepted level of geometrical precision

(0,3; 0,2; 0,12).

Thus, it is accepted that the form tolerance is some kind of equivalent of the allowed detail's sag. However other errors have impact on the form of a detail also. Generally errors can be as constants which action throughout processing of the same step of a shaft doesn't change, and variables the values of which is changing in a random way or according to a certain law. Then it is possible to select and systematize errors of processing of non-rigid details as follows:

1. Constant errors:

- the errors of the machines;
- the errors because of the setup on the size;
- the errors because of the low rigidness of technological system.

2. Variable errors:

- the errors because of the sag of details under the influence of the radial component force of cutting;
- the errors because of the sag of a cutter under the influence of tangential component force;
- the errors because of the wear of the tool;
- the errors because of the thermal deformations;
- the errors because of the influence of the previous types of processing.

It is obvious that only variable errors can have impact on the form of a detail in the longitudinal direction. It is possible to exclude from the further analysis of an error because of thermal deformations as in case of application coolant their value is unessential. The errors because of influence of the previous methods of processing (or technological heredity), on final operations too have insignificant impact on a form tolerance. Besides, their values can't be defined and considered authentically on blueprint stage of technological process, without direct measurement of a processed detail.

Thus, it is necessary to estimate influence on value of the tolerance of the form of two types of variable errors:

1. The errors because of sag of a cutter under the influence of the tangential component force of cutting (fig. 1):

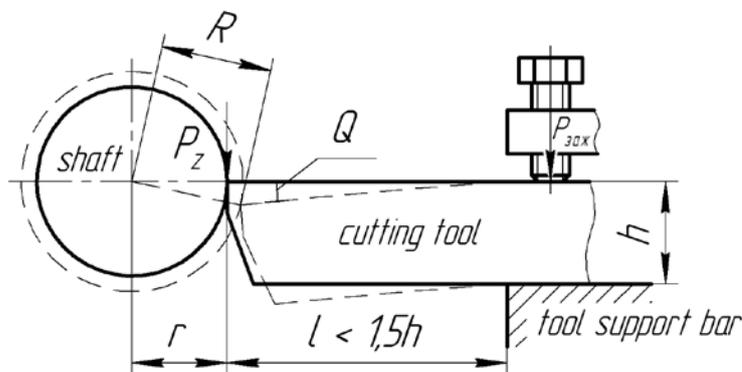


Fig. 1 The diagram of origin of an error under the influence of force P_z

From fig. 1 it is visible that the error because of the sag of a cutter under the influence of the component force of cutting of P_z in diametric expression is defined

as follows (in micrometers):

$$\delta = 2 \cdot (R - r) \cdot 10^3 \tag{3}$$

where R – the radius taking into account an error under action of P_z , (in millimeters);
 r – the basic radius, (in millimeters).

Relocation of a tool point under the influence of the component of the cutting force P_z can be defined from formulas of materials' resistance [3]:

$$y_{\max} = \frac{P_z \cdot l^3}{3 \cdot E \cdot I_z} \tag{4}$$

where l – the length of the tool between a lathe tool holder and blank ($l \leq 1,5h$);
 E – the module of normal elasticity;
 I – the inertia moment of the blank's section [3]:

$$I_z = \frac{a \cdot h^3}{12} \tag{5}$$

where a – the width of the cutter's base;
 h – the height of the cutter's base.

The angle turning of cutter point concerning a fixing point under the influence of force of P_z is defined by the following expression [3]:

$$Q_{\max} = \frac{P_z \cdot l^2}{2 \cdot E \cdot I_z} \tag{6}$$

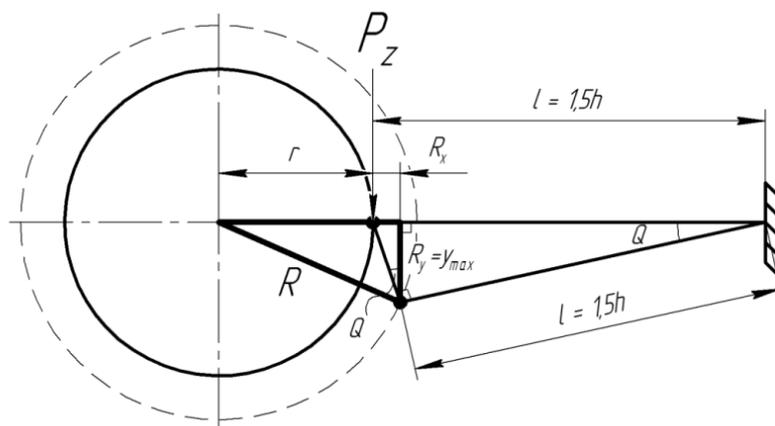


Fig. 2 The estimation scheme for determination of a new radius R

A new radius R can be determined as follows (fig. 2):

$$R = \sqrt{(r + R_x)^2 + R_y^2} = \sqrt{(r + y_{\max} \cdot \text{tg}(Q))^2 + y_{\max}^2} \tag{7}$$

where R_x – offset of a cutter point in the horizontal direction;
 R_y – offset of a cutter point in the vertical direction.

Numerical values of the errors connected with offset of a cutter depending on value of tangential component force of P_z for a cutter's base with the rectangular section of 25x16 mm (embarkation of a cutter no more than 1,5 heights of a cutter's base) from steel 40 are given in table 1:

Table 1

The calculation of the errors because of a cutter's offset under the influence of force P_z

P_z	h	a	E	y_{max}	Q	r	R_x	R_y	R	δ
N	mm	mm	MPa	mm	°	mm	mm	mm	mm	mcm
500	16	25	210000	0,0013	0,00008	50	50,0000001	0,0013	50,0000001	0,0002
600	16	25	210000	0,0015	0,00010	50	50,0000001	0,0015	50,0000002	0,0003
700	16	25	210000	0,0018	0,00011	50	50,0000002	0,0018	50,0000002	0,0005
800	16	25	210000	0,0021	0,00013	50	50,0000003	0,0021	50,0000003	0,0006
900	16	25	210000	0,0023	0,00014	50	50,0000003	0,0023	50,0000004	0,0008
1000	16	25	210000	0,0026	0,00016	50	50,0000004	0,0026	50,0000005	0,0010
1100	16	25	210000	0,0028	0,00018	50	50,0000005	0,0028	50,0000006	0,0012
1200	16	25	210000	0,0031	0,00019	50	50,0000006	0,0031	50,0000007	0,0014
1300	16	25	210000	0,0033	0,00021	50	50,0000007	0,0033	50,0000008	0,0016
1400	16	25	210000	0,0036	0,00023	50	50,0000008	0,0036	50,0000009	0,0019
1500	16	25	210000	0,0039	0,00024	50	50,0000009	0,0039	50,0000011	0,0022
1600	16	25	210000	0,0041	0,00026	50	50,0000011	0,0041	50,0000012	0,0025
1700	16	25	210000	0,0044	0,00027	50	50,0000012	0,0044	50,0000014	0,0028
1800	16	25	210000	0,0046	0,00029	50	50,0000013	0,0046	50,0000016	0,0031
1900	16	25	210000	0,0049	0,00031	50	50,0000015	0,0049	50,0000017	0,0035
2000	16	25	210000	0,0051	0,00032	50	50,0000017	0,0051	50,0000019	0,0038

Thus, it is obvious that this type of errors has unessential impact on value of the form tolerance of non-rigid details.

2. The errors connected to wear of the tool.

The radius that being increased due to wear of the tool is determined by a formula (9):

$$R = \sqrt{((\Delta_u \cdot ctg(10^\circ))^2 + (r + \Delta_u)^2)}, \tag{9}$$

where Δ_u – the value of wear of the cutting edge.

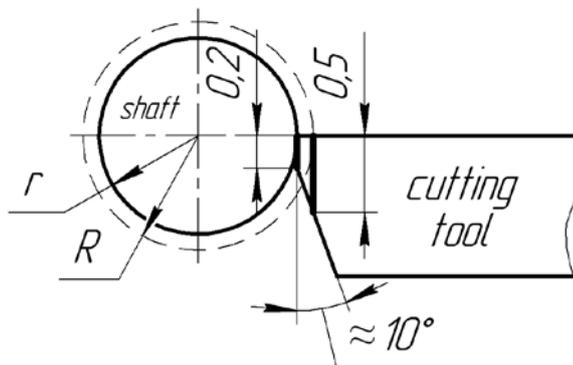


Fig. 3 The scheme of origin of an error, because of wear of a cutting tool

The error because of wear of the tool in diametric expression it is possible to calculate on the formula (8) given above.

Considering that, for example, wear of cutter for T30K4 is about 6 mcm/km [1], it is possible to define the error because wear of a cutter. For example it is necessary to process a shaft with diameter of $d = 80$ mm, length $L = 1000$ mm and supply of

$S = 0,1$ mm for one round of blank. The way of a cutter is determined by a formula [2]:

$$L = \frac{\pi \cdot d \cdot l_{\text{заг}}}{1000 \cdot S}. \quad (10)$$

That is, the way of a cutter in this case makes $L = 2512$ m = 2,5 km, wear – respectively $\Delta_n = 15$ microns, and the error in a diametric equivalent is $\delta = 30,2$ mcm.

On the one hand, this number is essential as it is commensurable not only with the tolerance of the form, but even with the tolerance on the size. However it is necessary to consider the next moments:

1. The error was defined on condition of processing of a whole shaft. In practice extremely seldom it is necessary to process smooth long shaft. Often shaft divided on the sections, and length of each section many times is less than length of a detail. Thus, over fall of diameters because of wear for each section will be much less.

2. Besides, the modern systems of CNC include subprograms which compensate wear in the course of cutting. In the simplest option the value of specific wear (mcm/km) for the specific cutting plate, and system of CNC adjusts cutter's peak coordinate taking into account its wear in processing.

Thus, the error because of wear is essential; however its influence can be minimized by CNC system in processing. Therefore in calculations on accuracy this error can be not considered, and the form's tolerance can be used as an equivalent of value of the maximum allowed detail sag under the influence of the radial component force of cutting of P_y in subsystems of [4] supports of accuracy of turning of non-rigid details.

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EQUIPMENT TO STRENGTHEN POTENTIALLY UNSTABLE SOILS BY THE METHOD OF ERECTING WALLS"

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Abstract. *The article describes the design of new equipment for the construction of bases of type "wall" used for the construction of underground structures and prefiltration screens. The results of experimental studies supporting the effectiveness of this equipment.*

Keywords: *equipment for the manufacture of reason "wall", a ground-cement piles, the working body with the pie conical stamp*

Currently, in large cities there is a necessity of construction of underground structures. The construction thus made under adverse conditions: dense urban areas, the presence of underground utilities and sewer, no impact on the foundations of nearby buildings, quiet building, etc.

In these conditions the most promising technology is a "wall in the ground", is widely used in the construction within the city, the reconstruction of buildings and structures in hydraulic engineering.

Using the technology of "wall" can also be constructed:

- shallow tunnels for subway;
- underground garages, overpasses and interchanges on highways;
- storage tanks for liquid and settling tanks;
- grout (Fig. 1) vertical and horizontal watertight bulkhead in the ground, located on one or more sides of the source filter to bar the movement of groundwater to be protected from flooding to structures. The most effective grout, brought to the aquitard is weak or impermeable soils. Injecting grout under construction by the method of stepwise drilling or punching wells with subsequent injection into them of cement, reinforcing the soil.

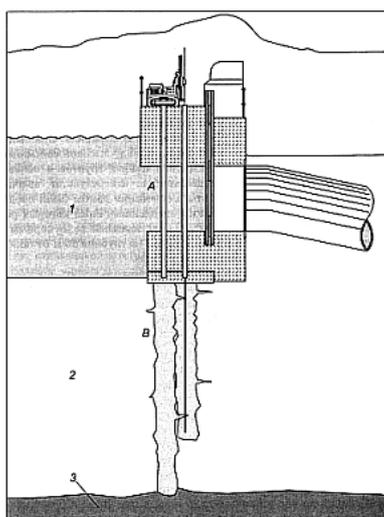


Fig. 1. The anti-filtration screen (for anti-seismic protection of cement-bound surfaces intersecting columns

The essence of technology "wall in the ground" is that in the soil arrange excavation and trenches of different configuration in plan, in which erect the building envelope underground structures from monolithic or precast concrete, then under the protection of these structures develop internal soil core, arrange the bottom and raise the internal design

Currently, there are many ways to build a "wall". In the practice of Foundation recently has clearly identified areas of development and introduction of new designs and technologies of conducting piling [1]. It relates to the device ground-cement piles, i.e., piles, which are made of fixed cement soil borehole. Ground-cement piles are manufactured with a diameter of 0.4-1.0 m, length 20 m, and are used in the construction of new buildings and renovation of existing ones. The method consists in a device of the enclosing structure of a continuous series of vertical ground-cement piles.

Technological scheme of production of ground-cement piles baromedical method includes the following operations:

- drilling of the receiving hole with a diameter of 0.1 m larger than the diameter piles (burocracies) screw holes on the emission depth of 0.5-2 m, which depends on the length arranged piles and physical properties of the used soil. The specified reception bore necessary for making excess cement genesis mixture formed by the introduction into the soil of water and cement. The depth of this well is determined depending on the physical properties of the soil (natural moisture content and porosity) and the amount of typing binder;

- drilling of ground paddle baromedicine with the simultaneous introduction of water in the amount necessary for transition crushed loess soil in a fluid state, provided that the humidity of the soil, which should be more humidity in the boundary fluidity;

- vyhloubene of burocraies with simultaneous supply of water to the suspension to the extent that the flow in the ground mass of the required quantity of cement;

- installation of the reinforcement cage in flowing ground-cement mixture. Existing methods of construction of enclosing structures from ground-cement piles have the following drawbacks:

- the complexity of the equipment. It is usually made on the basis of commercially available drilling equipment with complex pumping equipment, because you must create a high pressure jets of water and air. Thus, European and Japanese companies use the jet supply pressure 40...70 MPa. In this case, applying the jet nozzle diameter 1.5 to 2 mm, rarely up to 3 mm, For such values of the diameters of the nozzles there is a real danger of their driving. You must use very pure cement with a specific ratio of particles of different sizes. In order to improve the destruction of the soil and to reduce energy consumption in new construction monitors introduced nozzle, the feed pressure air (0,45 MPa) and water (5 MPa). It also requires the installation of additional pumps and compressors, which makes the equipment more complex, involving a number of different units;

- the inability to predict the size and the quality of the produced piles. This is because the erosion of the soil depends on many factors, such as type of soil, nature

of occurrence of seams, and so on, Therefore it is impossible to estimate the size of the piles and to calculate pile Foundation, in connection with this the number of piles in the Foundation unreasonably inflate;

- the presence of a large amount of water that remains in the well, and then leads to stratification of the ground-cement mixture;
- the significant terms of production piles, because it takes time to filter large amounts of water in the surrounding soil;
- the inability to seal ground-cement mixture and, as a consequence, the low strength of the resulting material piles (to 0.73 MPa);
- for high quality mixing cement with soil requires multiple passes baromedicine working body;
- high filtration coefficient finish walls, so that it is impossible to use this method for the construction of the grout curtain. The veil is not sealed purpose usually has a very low permeability, on the order of 10^{-9} cm/sec. But this permeability can be mainly at shallow depths and at sufficiently uniform soil properties. Increased permeability to 10^{-7} cm/sec may be at significant depths and in more difficult conditions the distribution of the veil, when it is necessary to reduce its permeability by filling the "Windows" minimize the distance between the axes of the columns or by assigning additional line of columns. Considering the fact that the full continuity of the veil cannot always be reached, the estimated value of its coefficient of filtration is recommended to take, is equal to $15 \cdot 10^{-5}$ cm/sec.

At Saratov state technical University at the Department of Construction and road machines" research equipment for the manufacture of ground-cement piles. A new method of making a ground-cement piles is to apply pie conical stamp making spherical motion [2,3].

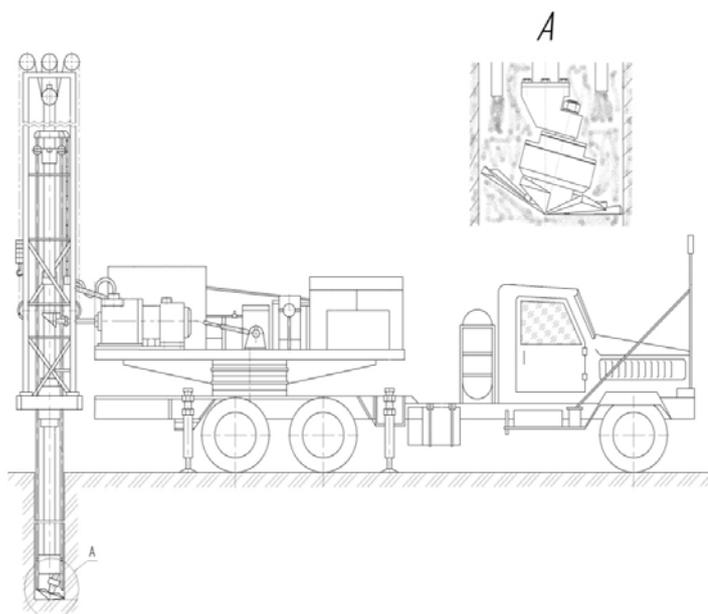


Fig. 2. Equipment for the manufacture of wall"

The equipment consists of a commercially available drilling rig and the working body of the original design (Fig. 2).

During the rotation of the vertical shaft in the direction of providing the

immersion of the working body, the stamp under the applied axial force produces a layer-by-layer cutting grinding ground sharp edges of the sectors. At the same time in the working area served cement, which is mixed with the loosened soil.

During the rotation of the vertical shaft in the opposite direction is releasing overrunning clutch, this stamp does precancerous movement.

While effects on the body vertical static load (sealing force) and precancerous motion is periodic rolling sectors stamp on the ground, waking up in small portions in a cross-sector space. Layers, portions compacting a soil working body, overcoming the sealing force, gradually comes to the surface, leaving a column of compacted soil - ground-cement pile. Next is the seal of the next layer.

The result is a body of piles with a lower permeability than the traditional way of building a "wall".

To determine the permeability of a sample of ground-cement piles, made using sector conical stamp was conducted experimental studies. According to the norms [4] the filtration coefficient of hardening and plastic fillers veils should not exceed $0.6 \cdot 10^{-5}$ cm/sec.

The filtration coefficient experimental samples (soil-cement manufactured with seal material sector conical stamp, on average $0,498 \cdot 10^{-5}$ cm/sec. Therefore, equipment with sector conical stamp to use effectively be used to create cut-off curtains and other engineering structures.

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O.L.Kuznetsova

THE WORKING BODY FOR THE MANUFACTURE OF HOLLOW PILES WITH REINFORCEMENT

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Abstract. *Methods and results of experimental studies of the working body with the annular tapered punch for manufacturing hollow bored reinforced piles.*

Keywords: *equipment for the manufacture of hollow piles, reinforcement of piles, the annular tapered punch, experimental studies.*

To date, construction of civil and industrial buildings it is impossible to imagine without the construction of pile Foundation. In many ways this is explained by the fact that with every year increase in the volume of construction of buildings and structures, including most closely located to the Central areas of cities in dense urban areas.

The wide distribution of pile foundations due to the large number of technologies in their construction. The most common technologies are: shock, vibration and vibro-impact ways of driving of piles, the construction of the piles directly in the ground (bored piles) and a static method, driving of piles (zadowolenie piles).

The use of drums or percussive method of driving of piles in dense urban areas is highly undesirable and dangerous. This is due to the presence of dynamic effects transmitted through the soil, the foundations of nearby buildings, which negatively affects the foundations of these buildings and can lead to cracks and even to partial collapse.

In dense urban areas is most appropriate to apply the methods of construction of piles without dynamic effects on the soil. Such methods include the method of construction of the piles directly in the ground - bored piles.

The method of construction of bored piles is quite expensive and often the cost of such a Foundation may be 15% of the estimated cost of the entire building.

This is due to the large number of technological operations, involving the drilling of wells, pumping wells concrete, immersion reinforcing frame, when the same difficulties with quality control of concrete and providing oversight of the pile shaft.

One of the promising directions of improving the design of bored piles is to develop techniques for device hollow piles.

The small volume application of hollow piles due to technological constraints of the device of the internal cavity. Currently proposed and patented a significant number of original ways devices bored piles-shells. However, the evaluation of their effectiveness is difficult, because most of them are not implemented. And only a small part has experienced, as a rule, onetime implementation.

At Saratov state technical University at the Department of Construction and road machines" developed the design of the equipment for the manufacture of hollow piles. The working body to make piles is a conical annular punch performing a

complicated spherical movement [1].

Tests have confirmed its effectiveness for the manufacture of hollow piles [2]. However, this equipment does not provide for reinforcement of the piles. Therefore, we carried out research and development work aimed at the performance of the equipment, allowing the reinforcement of piles.

For the manufacture of piles with reinforcement serves the following way (Fig.1):

- drilling of bore diameter d ;
- in the well immersed reinforcement cage and is centered about the axis of the borehole. The diameter of the reinforcement cage should be equal $D_a = d - (30 - 40)$ mm;
- in the cavity of the reinforcement cage is immersed into the working body, the punch diameter which is equal to $D = D_a - (10 - 15)$ mm.

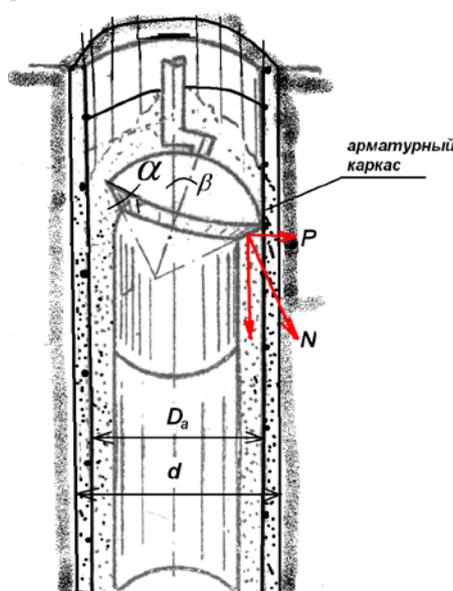


Fig.1. The scheme of manufacturing a hollow reinforced bored piles

Then starts the supply of concrete mixture with simultaneous inclusion of actuator rotation of the vertical shaft and the creation of axial pressure. When the stamp starts to make complex spherical motion and roll along the circular gap between the borehole wall and the core, where there is a concrete mixture.

With this method of production piles should create a high pressure sealing concrete mixture on the walls of the well, as it is necessary to push the mixture through the armature frame.

Studies have shown that the pressure on the walls of the well depends on the angles of its own axis of rotation of the plug from the vertical position β and angle of the inclination of the generatrix of the conical surface of the plug α . According to the scheme in Fig.1, the radial pressure on the walls of the well is determined by the formula:

$$P = N \sin(\alpha - \beta),$$

где N - the normal contact pressure.

In the existing structures of the working body was taken to the ratio of angles $\alpha = \beta$, relieving pressure on the borehole wall was created only due to the lateral pressure of the sealed mixture. Therefore, experimental studies were performed to determine the optimal values of these angles.

Experimental studies were conducted on the model of the working body in the form of imitating the borehole with a diameter of 140 mm In the form of installed grid to simulate the reinforcement cage (Fig. 2).

For the measurement values of lateral pressure of the mixture in the form produced through hole, into which is inserted a movable stopper. Mobile tube rested on a flexible beam which is in contact with the movable contact of the load cell. The readings of the load cell were recorded with special equipment.

Model dimensions: minimum borehole diameter $d=100$ mm; core diameter $d_c = 80$ mm; core size - 80 mm.

Sealing plug models had a removable conical ring, which allows to change the ratio of the angular parameters of the working body.

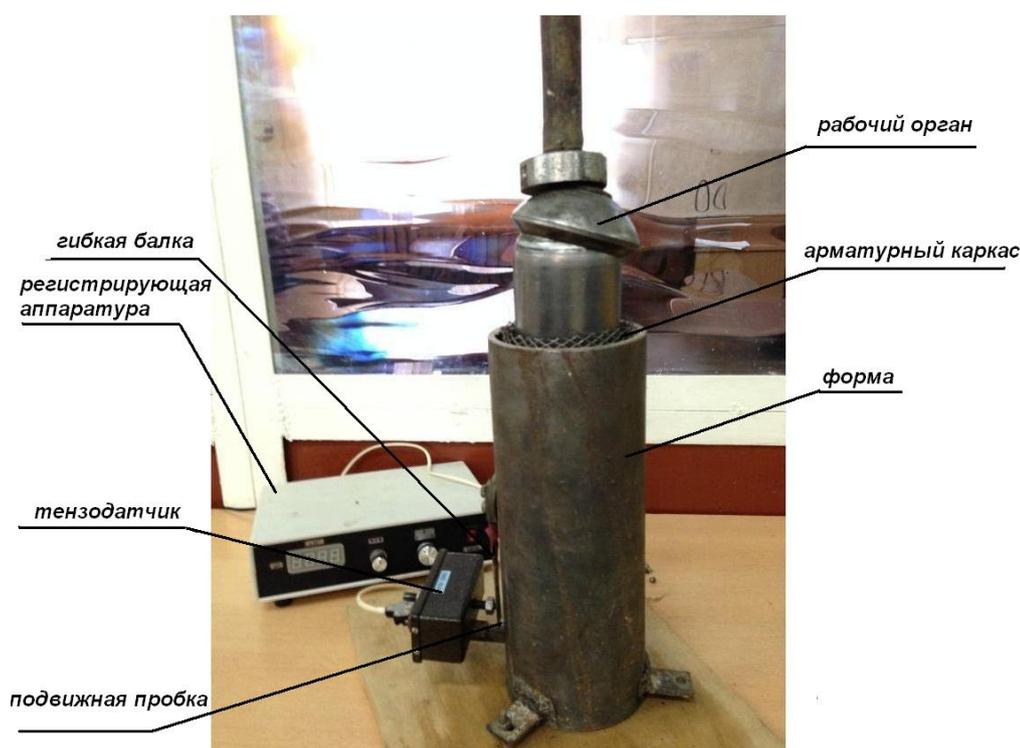


Fig. 2. Experimental equipment

Just tested the model with the following parameters:

1 model - $\alpha = \beta = 15^{\circ}$

2 model- $\alpha = 30^{\circ}, \beta = 15^{\circ}$.

The model was mounted on the shaft supporting the experimental equipment. Static weights during pressing was created by a set of weights, which are also

installed on the shaft.

When conducting experimental studies of axial load was estimated by the parameter given axial pressure, which was defined as:

$$q = \frac{Q}{0,25\pi(d^2 - d_c^2)},$$

where: Q - the value of static weights, kN.

The interval of variation of axial load $q=25$ kPa - 150 kPa.

As we fall asleep in the shape of the material used wet sand, simulating the hard concrete with a slump of 0. The experiments were carried out in the following sequence. On the shaft fixed working body with predetermined geometrical parameters. The set of weights was created the desired value of the axial weights. During the rotation of the shaft in the form began with the presentation of the material. When the seal material on the walls of the form and the surface of the tube was created pressure that moved the tube in the radial direction. The shift tube thus depended on the magnitude of the pressure. The tube was curved flexible element, which shifts the movable contact strain gauge, thereby altering the electrical signal, which was recorded by the measuring instrument. In the experimental studies presented in Fig.3.

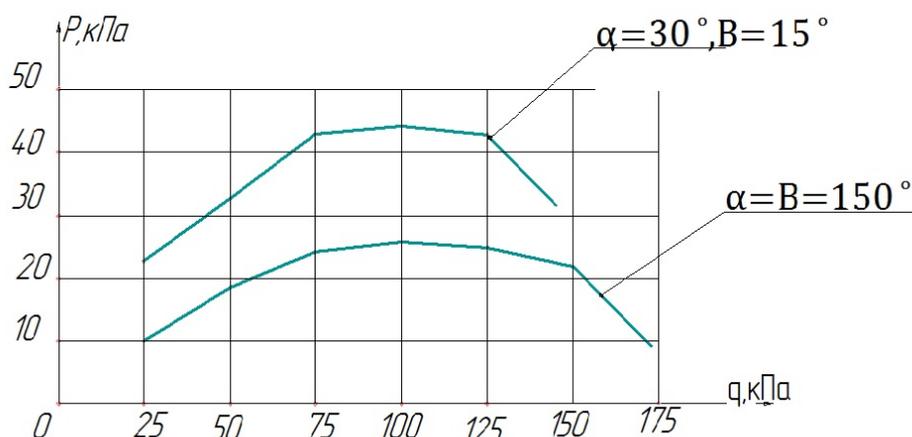


Figure 3. A plot of the radial pressure (P) from the geometrical parameters of the working body (α, β)

The findings of experimental studies:

1. In the experimental studies found that the compaction of the concrete mix is created considerable pressure required for forcing material through the reinforcing cage. Therefore, it is possible to manufacture reinforced piles.

2. As can be seen from the graph in Fig.3, increasing the angle of inclination of the generatrix of the conical surface in α comparison with the angle of inclination of the axis of rotation of the conical punch β leads to an increase in the radial pressure of 18-20%, which is especially important if you are going reinforcement of piles and need to break through the reinforcing cage.

3. Radial pressure is transmitted to the walls of the well increases with

increasing axial weights. However, the increase in static pressure above 100-125 kPa, starts squeezing the mixture up through the annulus between the borehole wall and the punch.

4. Experimental studies have proven the ability to produce reinforcement piles conical working body. It has also been proved that the change of the relationship between the angles of the tapered surfaces of the punch and the deviation of its axis from the vertical increases the radial pressure, which allows the most complete punching reinforcement cage. The resulting experimental data are used for calculation and design of equipment for the manufacture of hollow piles.

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MATHEMATICAL DESCRIPTION OF THE PROCESS IMPACT ON THE GROUND WORKING ELEMENTS MERCATORHALLE EQUIPMENT

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Abstract. *This paper proposes new equipment for the development of frozen soils engaged in unstressed destruction and mathematical description of the interaction process of working organs of the developed environment.*

Keywords: *frozen soil, mercatorhalle equipment, screw tip, loosening the rod, cramped conditions.*

At the present stage of development of methods and means of mechanization in the area of development of frozen soils unresolved issue is the implementation of a small amount of work in difficult construction conditions. These conditions are characterized by a negative temperature, which leads to an increase of the strength properties of the developed environment, and cramped conditions associated with dense urban development. The existing variety of methods and mechanization, does not allow to directly solve this problem, because the presence of complex conditions severely limits the use of many different ways to develop soil. In the main limiting factors are the dimensions of the power and influence of the breaking load and, in spite of high performance use them in cramped conditions[3,4].

At the present time for the development of small volumes of soil in difficult conditions most widely handheld jackhammers due to the lack of other advanced machines capable of competing with them, and despite the considerable disadvantages which include both the shock - vibration and noise, this remains the only tool on the market.

This problem will allow to solve new design Mercatorhalle tool engaged in the destruction of soil, major spalling realizing less energy-intensive process of destruction. Working bodies Mercatorhalle of the tool consists of a screw lugs engaged traction function, followed by followed by rod cone shape, they carry out destructive function by increasing the cross-section of the rods to their base[1,2] .

Basic design parameters that affect the power characteristics of the tool are (Fig.1):

-Geometrical parameters of the spiral tip: the maximum diameter of the helical blade ; step helix t ;

- Geometrical parameters loosening rods: the angle of taper generatrix of the conical surface of the rod ; the distance from the upper helical blade to the lower base of the cone H_2 ; the distance between the screw working bodies L ; the height of the cone rod H_{uu} ; the radii of the bases of the truncated cone R_1 and R_2 .

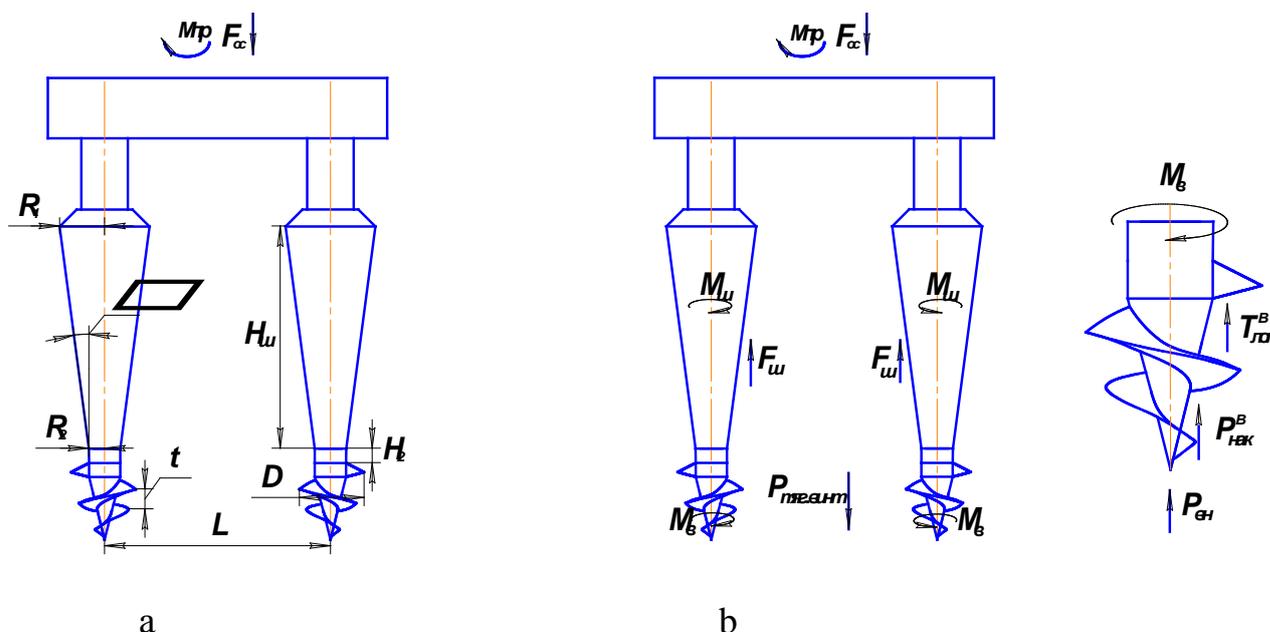


Fig. 1. The main parameters Mercatorhalle equipment: a-the main structural parameters; b-basic power settings.

For efficient operation Mercatorhalle tool you need to meet the conditions under which the screw tips, savienibas in the soil, provide the ability to dive for a loosening of the rod to reach the critical depth at which occurs a separation element soil towards the bottom.

This condition is ensured by the force balance between the traction ability of the screw tip and the forces of resistance to the introduction of these tips, as well as by the external load applied to the screw tips from exposure to forces of resistance to loosening rods cone forms [4,5].

In General, this condition has the form:

$$P_{m\ddot{a}z} = \sum P_{i.cpeza} \geq F_{cnp} = T = \sum P_i + W \tag{1}$$

- where:
- $P_{\text{тяг}}$ the traction capability of the screw tip;
 - F_{cnp} force of resistance to the introduction of the working body;
 - T force of resistance to the introduction of lead-in area of the screw tip;
 - W the strength of the external load;
 - $\sum P_i$ the sum of the resistance forces ground indentations on the composite surfaces of the screw tip;
 - $\sum P_i$ the sum of the forces of resistance of the soil slice on the surface of the conical and cylindrical sections of the helical blades;

The traction capability of the screw tip is characterized by the bearing capacity of the soil, which is the amount of resistance of the soil slice on the surface of the conical and cylindrical sections helical blade $\sum P_{i.cpeza}$ subject to the deduction of internal forces resistance to soil compression on these sites helical blade from the action attached to it loads:

$$P_{m\ddot{a}z} = (P_{1.cpeza} - T_1) + (P_{2.cpeza} - T_2) - W \tag{2}$$

where: T_1, T_2 the compression force of the soil of the upper screw blade on the conical and cylindrical sections from the action of applied loads;

Recommendations [4,5] these values can be determined by existing dependencies:

- power resistance of the soil slice on a tapered section of the screw blades:

$$P_{1.чрезза} = \left[\frac{S_{1.чрезза} \cdot c + \sigma_{1.чрезза} \cdot tg\phi}{1 - tg\left(\frac{\pi}{2} - \alpha\right) \cdot \cos\beta \cdot tg\phi} \right] = \left[\frac{\frac{c \cdot \pi \cdot R^2}{\sin\beta} + tg\phi \cdot [P_1 \cos(\alpha + \beta) + P_2 \cos(\delta - \beta) + P_3 \cos(\beta - \gamma)]}{1 - tg\left(\frac{\pi}{2} - \alpha\right) \cdot \cos\beta \cdot tg\phi} \right] \quad (3)$$

- power resistance of a soil to cut on the cylindrical section of the helical blades:

$$P_{2.чрезза} = \left[\frac{S_{2.чрезза} \cdot c + \sigma_{2.чрезза} \cdot tg\phi}{1 - tg\left(\frac{\pi}{2} - \alpha\right) \cdot tg\phi} \right] = \frac{c \cdot 2\pi \cdot R^2}{\left(1 - tg\left(\frac{\pi}{2} - \alpha\right) \cdot tg\phi\right)} \quad (4)$$

According to (3), (4) resistance of a soil to determine the maximum shear traction force, developed a screw tip.

Power T_1, T_2 attached to the upper surface of the helical blade are determined based on the sum of the forces of resistance to the introduction of the screw tip $\sum P_i$ on the characteristic plot of the helical blade.

- the compression force of the soil of the upper screw blade on the conic section:

$$T_1 = \frac{|P_2 \sin\delta + P_3 \sin\gamma - P_1 \cdot \sin\alpha|}{1 + \left[3 \cdot n_2 \frac{\alpha_1^2 - \alpha_2^2}{(\alpha_1 - \alpha_2)^2 \cdot n_1^2} \right]} \quad (6)$$

-the compression force of the soil of the upper screw blade on the cylindrical section:

$$T_2 = \frac{|P_2 \sin\delta + P_3 \sin\gamma - P_1 \cdot \sin\alpha|}{1 + \left[\frac{(\alpha_1 - \alpha_2)^2 \cdot n_1^2}{3 \cdot n_2 (\alpha_1^2 - \alpha_2^2)} \right] \cdot \sin\alpha} \quad (7)$$

where: P_1, P_2, P_3 - force of compression of the soil in the indentation in the ground elements of the screw tip, the upper and lower surface of the helical blade and a tapered core.

The dependence of the forces applied to the helical blade T_1, T_2 (6),(7) are the internal forces of resistance to the introduction of the screw tip under the action of the applied load, so with the removal of these forces from the equation for determining the traction we define the stock traction capabilities that can be implemented in the

power of the external load applied to the screw lugs. That is, in our case when working Mercatorhalle equipment it is the force of resistance to the introduction of loosening rods.

On the basis of the stock traction capabilities of screw tips are necessary to determine the effective geometrical parameters loosening rods for the implementation of the ratio of the highest volume beveling of soil from the geometric parameters of the rods with a minimum intensity of the destruction process. Parameters loosening rods affect the soil resistance F_{uz} which corresponds to the forces of the external load W applied to the screw tips (Fig.2.).

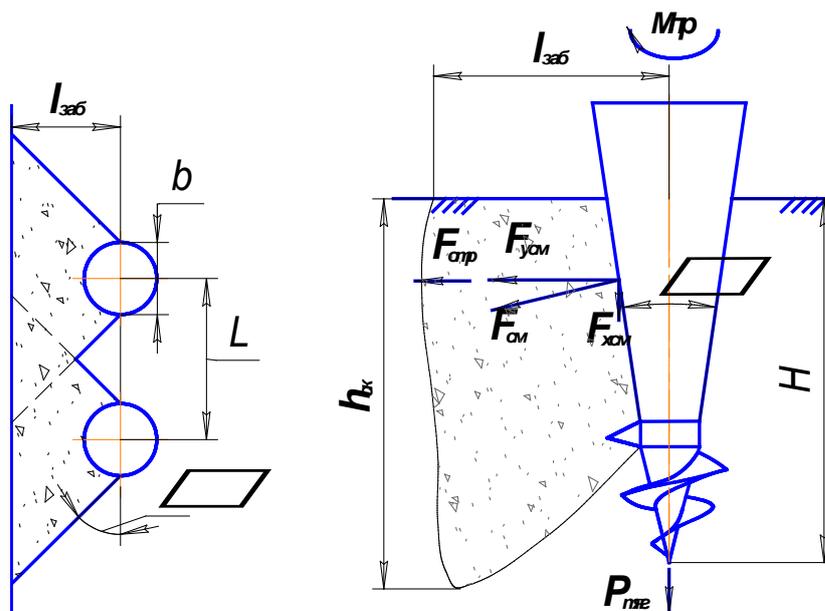


Fig.2. The scheme for determining the resistance forces of the soil introduction

In the process Mercatorhalle equipment under the action of the traction force loosening the rod embedded in the soil, the implementation process will prevent the force of resistance of a soil to compaction $F_{см}$, the resistance of the soil friction $F_{фр}$ and resistance of a soil to detachment towards the open wall of slaughter $F_{отп}$.

$$W = 2F_{uz} = F_{см} + F_{фр} + F_{отп} \tag{7}$$

where: power resistance of a soil to implementation loosening rods;
 power resistance of a soil to compaction loosening rods;
 power resistance of the soil friction on the surface of the rod;
 power resistance of a soil to detachment towards the bottom.

The magnitude of the normal forces of the collapse of the soil on the surface of the rod cone shape is determined by:

$$F_{см} = [P_{\sigma}] \cdot S_{бок} \tag{8}$$

where: specific soil resistance to penetration;
 the area of the side surface of a truncated cone.

The area of the side surface of a truncated cone is determined by the well-known formula through the radii of the base and the angle of inclination of the generatrix to

the ground plane:

$$S_{\text{бок}} = \frac{\pi \cdot (R^2 - r^2)}{\sin \alpha}; \text{ then: } F_{\text{см}} = [P_o] \cdot \frac{\pi \cdot (R^2 - r^2)}{\sin \alpha}$$

where: R,r - upper and lower base of the truncated cone.

The magnitude of the force of resistance of the soil friction on the lateral surface of a truncated cone $F_{\text{мп}}$, is expressed as the product of the normal force shear soil $F_{\text{см}}$ on the coefficient of friction f_c , where the coefficient of friction is equal to the angle of internal friction, $f_c = \text{tg} \varphi$ therefore:

$$F_{\text{мп}} = F_{\text{см}} \cdot f_c = F_{\text{см}} \cdot \text{tg} \varphi; \text{ then: } F_{\text{мп}} = [P_o] \cdot \frac{\pi \cdot (R^2 - r^2)}{\sin \alpha} \cdot \text{tg} \varphi \quad (9)$$

where: f_c is the coefficient of friction.

In the application to loosening rods traction on the surfaces of the rods will be the force tending to tear or chopping element of solid ground, with frozen ground has a resistance acting on the load which will be a side value of soil strength $\tau_{\text{нр}}$.

Therefore, the resistance of a soil to detachment can be determined by the formula:

$$F_{\text{отп}} = \tau_{\text{нр}} \cdot S_{\text{отп}} \quad (10)$$

where: τ side value of soil strength;
 S area separation.

The area of isolation is simplified can be defined according to the following dependence:

$$S_{\text{отп}} = |2(a \cdot H) + (b \cdot H) + a \cdot \sin(180^\circ - \gamma) \cdot b + a \cdot \cos(180^\circ - \gamma)|$$

where: a line spalling $a = l_{\text{заб}} \cdot \sin \gamma$;
 H depth of the dive;
 b the width of the upper base loosening the rod.

This dependence (10) characterizes the process of ground resistance loads, aimed at the gap or split element towards the bottom from the maximum width loosening element, the distance from the bottom and corners of the chip, determining the area of separation.

Substituting equations found (8),(9),(10) in the expression (7), we obtain the dependence of the resistance of the ground implementation, which represents the strength of the external load $W_{\text{воздействующей}}$ screw tips.

The dependence (7) is characterized by an external force acting on the screw tips and expresses the interaction loosening rods aimed at the destruction of the soil mass, and also allows to determine the influence of geometrical parameters on the efficiency of the process with regard to stock the traction capabilities of the screw tip in accordance with the equation of force balance (1).

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SHAVINGFORMATION AND CONTACT INTERACTION FOR WANT OF DISCONTINUOUS CUTTING

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Abstract This work is devoted to researching shavingformation and contact interaction for want of discontinuous cutting.

Key words: shavingformation, contact interaction, discontinuous cutting.

The contact interaction at the moment of an output(exit) is more convenient for studying not on the radicals of shavings, and with the help of microslices of a contact zone on extremities of shavings. The special importance of contact interaction in an extremity of a working course(during) (at the moment of an output(exit) of a cutting tooth from treated bar) is connected to outcomes of numerous researches indicating large influence to stability(resistance) of a mill it of a position concerning bar, and first of all of conditions of an output(exit) [1]. For want of it, as show the present researches, with stability(resistance) of the tool in the greater degree the angle of an output(exit) (angle between a vector of a velocity of cutting is correlated at the moment of an output(exit) of a tooth and free surface of bar, fig. 1), instead of the magnitude "K", representing a distance(span) from a surface of bar on which tooth of a mill leaves from contact to it(her), up to a tangent to a trajectory of a tooth of a mill conducted in parallel to submission.

Present and earlier conducted researches is established(installed), that depending on conditions of an output(exit), deriving three baseline designs of contact zones is possible. For want of angle of an output(exit) $\varphi \sim 85^\circ$ (fig. 1, b) contact zones on an extremity of a shaving are fixed in full volume and in that kind, which she(it) had during cutting on a main body of length of a path of cutting (fig. 2, b).

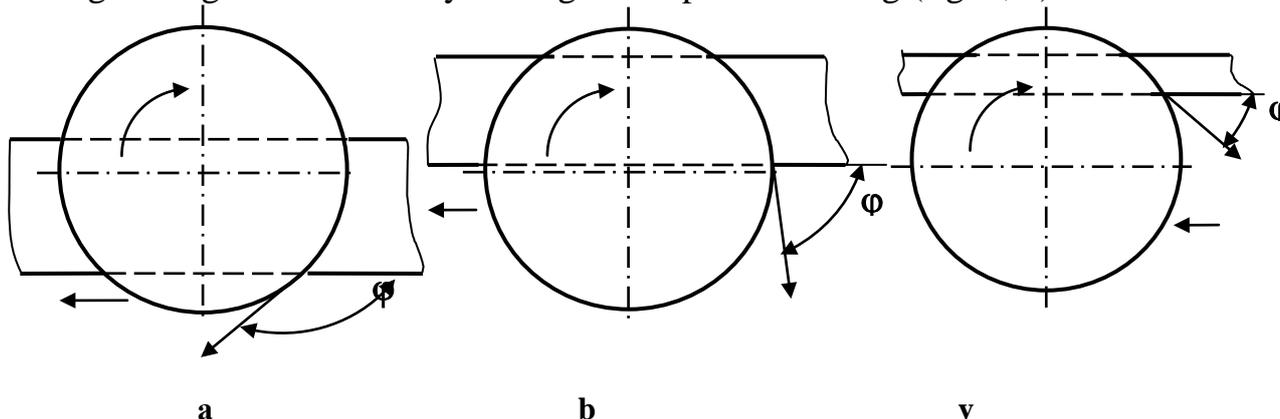


Fig. 1. Diagram of the relativ position of the cutter on the workpiece
(a - $\varphi \sim 135^\circ$; b - $\varphi \sim 85^\circ$; v - $\varphi \sim 30^\circ$;))

That is, it is possible to assume, that the separation of a shaving from a forward surface of the tool and cutting edge at the moment of an output(exit) of a tooth happens for want of maxima of a force of adhesive interaction.

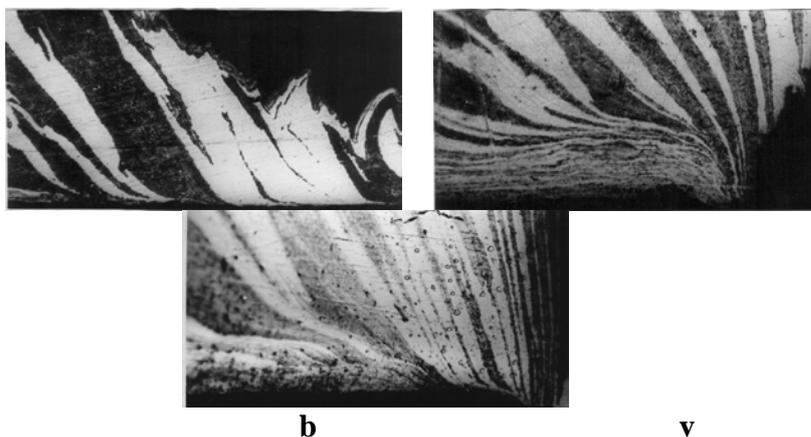


Fig. 2. View contact zone at the end of the chip
(a - $\varphi \sim 135^\circ$; b - $\varphi \sim 85^\circ$; v - $\varphi \sim 30^\circ$;))

That it is valid so, is confirmed by a kind of a surface of a shaving on which plot(site) the printed traces of sharpening of a forward surface of the tool (fig. 3, b) are well visible to appropriate plastic contact.

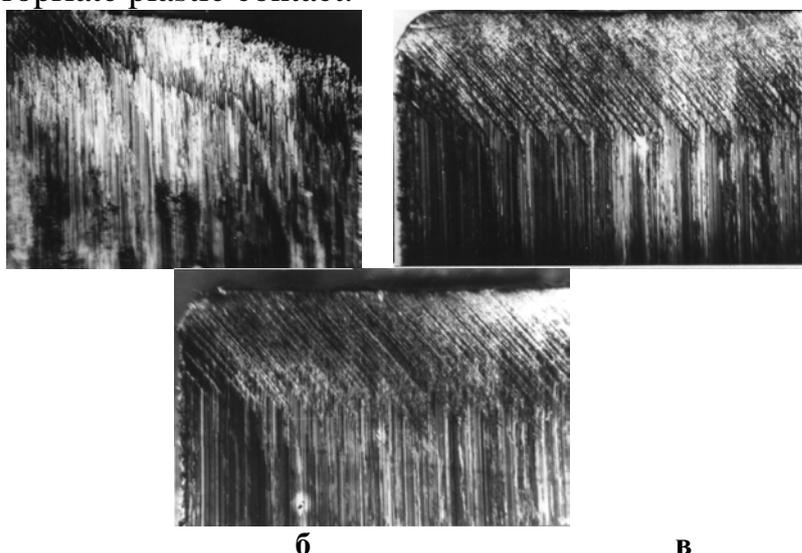


Fig. 3. View contact surface on the end of the chip
(a - $\varphi \sim 135^\circ$; b - $\varphi \sim 85^\circ$; v - $\varphi \sim 30^\circ$;))

For want of angle of an output(exit) $\varphi \sim 30^\circ$ (fig. 1, v) contact plastic deformations on an extremity of a shaving also exist (fig. 2, v). However, it is well visible, that sizes of deformable volumes is significant less and zone is in process of degeneration. Nevertheless, as the adhesive interaction has disappeared not completely (though and considerably less, than in the previous case) on the chisel party of a shaving traces of sharpening (fig. 3, v) also were saved.

The third variant for want of angle of an output(exit) $\varphi \sim 135^\circ$ (fig. 1, a) sharply differs from two previous. As it is visible from fig. 2, a on a part of a shaving, to it accumbent on a surface of a chisel, the plastic contact current completely is absent. The kind of a surface of a chisel on the shaving also testifies that on all length of contact on a forward surface of the tool has a place external friction (fig. 3, a).

It is necessary to mark, that the magnitude of angles of an output(exit), which corresponds(meets) to that or other kind of a contact zone at the moment of an

output(exit), depends mainly on properties of a treated material (first of all of hardness or plasticity), and also from modes of processing, defining temperature level. Indicating indirectly testify also to it data's, that the effect from a displacement of a mill for want of to processing rigid and more of ductile materials is various.

Comparative analysis of these three variations of the output of the tool allows you to assume the following. Optimal, from the point of view of minimum wear, such conditions are output when there is a complete disappearance of the zone of contact of the plastic deformation and the formation of a significant Burr. For the above cutting conditions such option is to exit with an angle of 135° . For exit angle of 85° cutting conditions are most unfavorable. In addition to the separation of the contact zone with the possibility of chipping of the cutting edge, in this case, there is a sharp discharge of the cutting wedge in the removal of chips from the workpiece.

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REACTIVE POWER COMPENSATION BY USING PWM BOOST RECTIFIER IN POWER SUPPLY SYSTEM

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Abstract. This article proposes a system control of mode reactive power compensations of PWM boost rectifier as part of the modern electric drives, which allows to increase the power factor of the power supply system. The control algorithm of PWM boost rectifier in mode reactive power compensations is proposed depending on the operating conditions of the electric drive. The analysis of the results revealed, that when working PWM boost rectifier with maintaining power factor on level -0.8 maximum power consumption of the drive is reduced by 25%, because of limitations of the current converter. To ensure maximum load of electric drive when working PWM boost rectifier with the power factor equal to -0.8, the authors propose a reactive power controller in the circuitry of reactive current, which limits the amount of generated reactive power at the maximum load of electric drive.

Keywords—PWM boost rectifier, power supply system, reactive power compensation, power factor, electric drive.

Introduction. There is a large class of consumers which require adjustable stabilized constant voltage or current and the possibility of bidirectional power to be supplied with. Currently Active Front End rectifiers are widely applied. They are used in electric drives, in automated systems of technological processes etc. [1]. In view of their increased application, another breed of rectifiers has been developed using new solid-state self-commutating devices such as MOSFETs, insulated gate bipolar transistors (IGBTs), gate-turn-off thyristors (GTOs), etc. [2]. PWM Boost convertor has become the most popular scheme of the converter used for the supply of industry electric drive [3].

When connected PWM Boost rectifier to the power supply system parallelly with nonlinear load it can act as an active filter. When working on the power supply system at the connection point with various consumers of reactive power, it can compensate the inactive component of the apparent power created by the load, and symmetrize energy consumption by phases as well, if the load is asymmetric [4].

This operating principle of PWM Boost rectifier allows to regulate the power factor of the power supply system. The control of PWM Boost rectifier in modes of reactive power compensation is one of the most effective ways to optimize electricity supply [5].

The aim of this work is the development and study of modes consumption control system and the generation of PWM Boost rectifier reactive power.

The studies were carried out by mathematical modeling in the Matlab/Simulink.

Description of PWM boost rectifier. PWM boost rectifier is a fast-acting PWM rectifier, the basic elements of which are a three-phase bridge on base IGBT

modules, a reactor, a filter at the AC mains and a capacitor in the DC bus. Schematic diagram is shown in Fig. 1. [6].

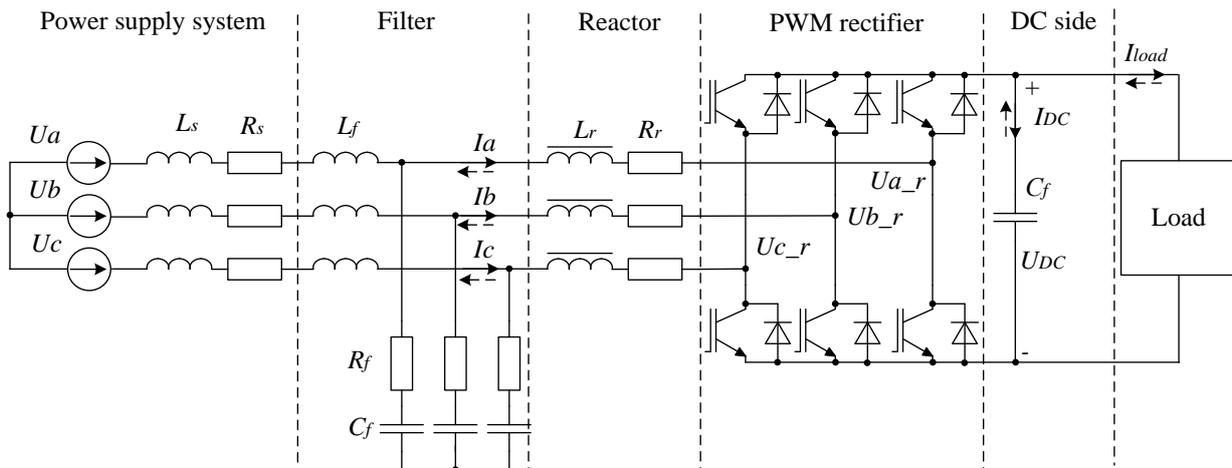


Fig. 1. Schematic diagram of PWM Boost rectifier

The equations of equilibrium of voltages for this circuit is as following:

$$\begin{bmatrix} U_a \\ U_b \\ U_c \end{bmatrix} = R_s \begin{bmatrix} I_a \\ I_b \\ I_c \end{bmatrix} + L_s \frac{d}{dt} \begin{bmatrix} I_a \\ I_b \\ I_c \end{bmatrix} + L_f \frac{d}{dt} \begin{bmatrix} I_a \\ I_b \\ I_c \end{bmatrix} + R_r \begin{bmatrix} I_a \\ I_b \\ I_c \end{bmatrix} + L_r \frac{d}{dt} \begin{bmatrix} I_a \\ I_b \\ I_c \end{bmatrix} + \begin{bmatrix} U_{a_r} \\ U_{b_r} \\ U_{c_r} \end{bmatrix}$$

For the convenience of the regulation and investigations construction system of various processes the system of axes dq is going to be used further. This will provide the ability to manage separate active and reactive components of the apparent power at the input of the PWM Boost rectifier. The equations of equilibrium voltage in the system of axes dq [7]:

$$\begin{bmatrix} U_d \\ U_q \end{bmatrix} = R_c \begin{bmatrix} I_d \\ I_q \end{bmatrix} + L_c \frac{d}{dt} \begin{bmatrix} I_d \\ I_q \end{bmatrix} + L_\phi \frac{d}{dt} \begin{bmatrix} I_d \\ I_q \end{bmatrix} + R_p \begin{bmatrix} I_d \\ I_q \end{bmatrix} + L_p \frac{d}{dt} \begin{bmatrix} I_d \\ I_q \end{bmatrix} - \omega L_p \begin{bmatrix} I_q \\ -I_d \end{bmatrix} + \begin{bmatrix} U_{nd} \\ U_{nq} \end{bmatrix}$$

Block scheme of vector control of PWM Boost rectifier is shown in Fig. 2.

On the side of the AC in the channel of feedback in the voltage and current, a system of filtering signals is provided. Then the signals cleaned from harmonics pass to the phase lock loop (PLL) and coordinate converters $abc \rightarrow dq$ vector supply power system of phase currents and voltages measured by sensors CS_a , CS_c and VS_a, VS_b, VS_c . The feedback signals current and voltage in the system of axes dq are transmitted to the input and output current controllers PI_d and PI_q , as shown in fig. 2. Signals deviation are processed by regulators of current and after the addition of the cross-coupling compensation signals are input to coordinate transformation $dq \rightarrow abc$. As a result of the inverse coordinate transformation controllers of the impact $U_{a_ref}, U_{b_ref}, U_{c_ref}$ are formed on the information input vector modulator.

The internal system of automatic control system (ACS) of active current I_d is submitted to external voltage control loop DC link with voltage regulator PID_C [8]. The synthesis of controllers is executed by submissive control principle with step-by-step correction. The reference signal from the control system of reactive power

is transmitted to the input reactive power regulator I_q and determines the mode of generation or consumption of reactive power or exchange with the supply power system only by the active power.

The instantaneous value of active and reactive power at the input PWM Boost rectifier [9]:

$$P = U_d I_d + U_q I_q, \quad Q = U_q I_d - U_d I_q$$

Provided accurate synchronization with supply power system $U_q = 0$. Power factor is defined as:

$$\cos(\varphi) = \frac{P}{S} = \frac{U_d I_d + U_q I_q}{\sqrt{(U_d I_d + U_q I_q)^2 + (U_q I_d - U_d I_q)^2}} = \frac{I_d}{\sqrt{I_d^2 + I_q^2}}$$

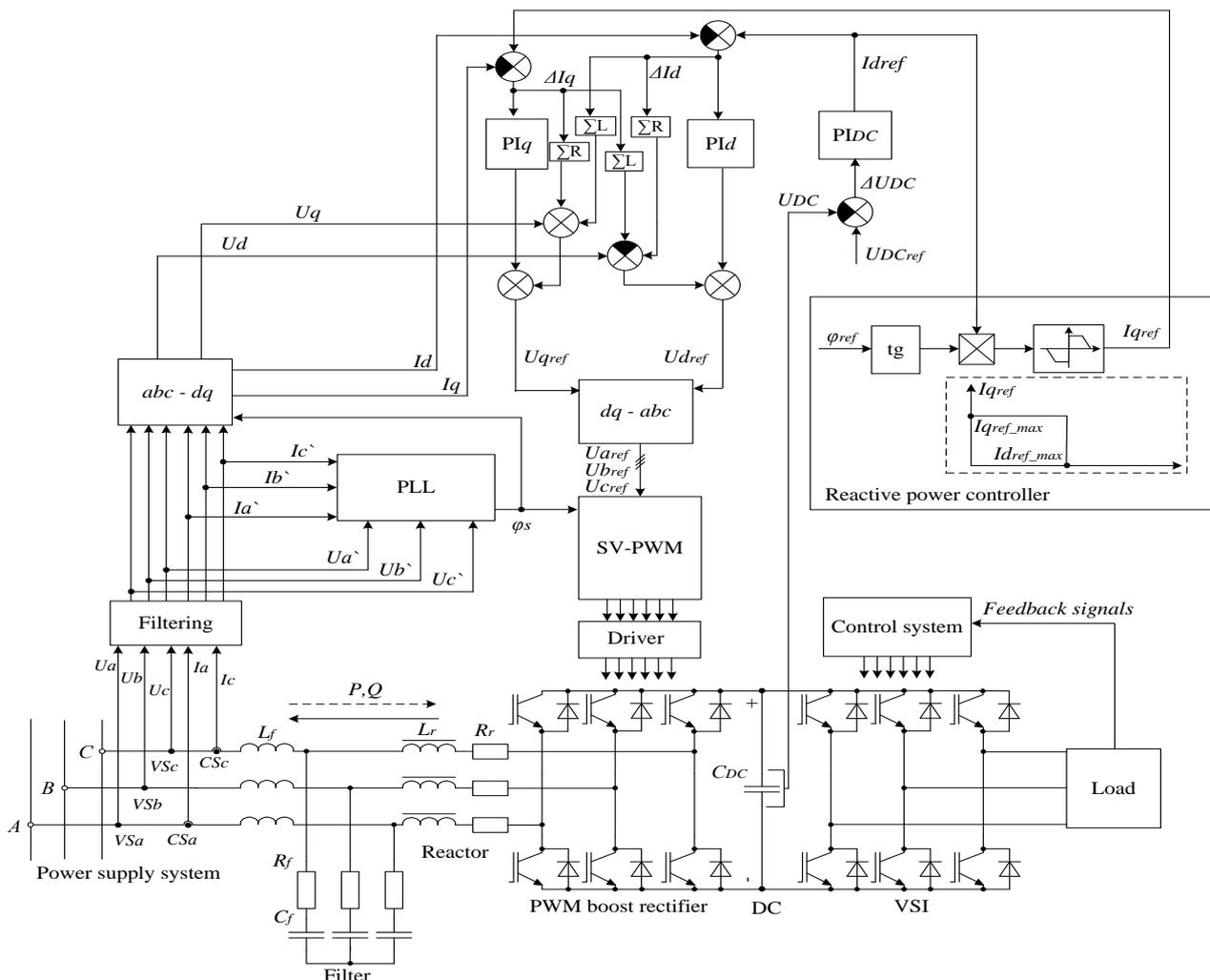


Fig. 2. Block scheme of of the investigated model

In modern PWM Boost rectifier the range of power factor is limited between 0.8 to -0.8. The magnitude of the reactive current I_q is determined by $\cos(\varphi) = -0.8$:

$$\cos(\varphi) = \frac{I_d}{\sqrt{I_d^2 + I_q^2}} \rightarrow \frac{I_d^2 (1 - \cos(\varphi)^2)}{\cos(\varphi)^2} = I_q^2 \rightarrow I_d \cdot \tan(\varphi) = I_q$$

$$I_q = -0,75 I_d \rightarrow I_{qmax} = -0,75 I_{dmax}.$$

Consequently, the operation of PWM Boost rectifier in the mode of generation reactive power with $\cos(\varphi) = -0.8$ limits the maximum power by 25%, provided that the maximum apparent power of PWM Boost rectifier is equal to the maximum power of the electric drive [10].

$$S_{conv_max} \cong P_{Load_max} \cdot$$

Simulation of reactive power compensation. Verification of the results was carried out on a mathematical model based on the scheme shown in Fig. 2 in the program Matlab/Simulink. The curves of transients in motoring mode of the electric drive working with $\cos(\varphi) = -0.8$ are shown in fig. 4. Fig. 5 shows analogous transients in the generator mode of the electric drive.

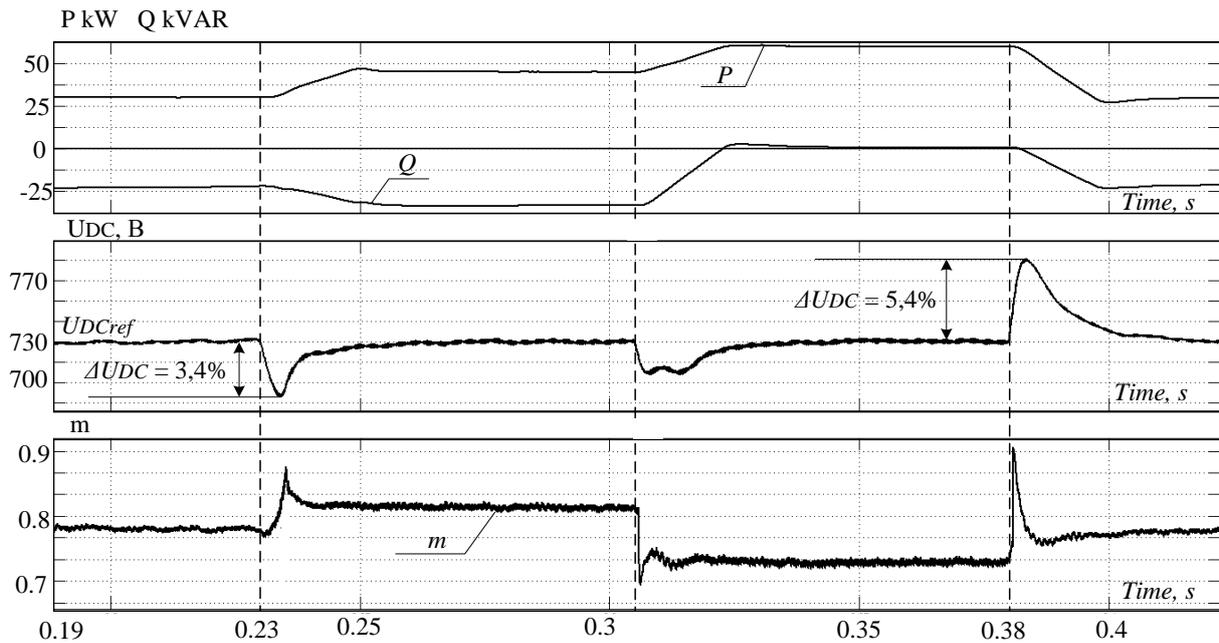


Fig. 3. Curves of transients of the electric drive motoring mode when operating PWM boost rectifier with $\cos(\varphi) = -0.8$.

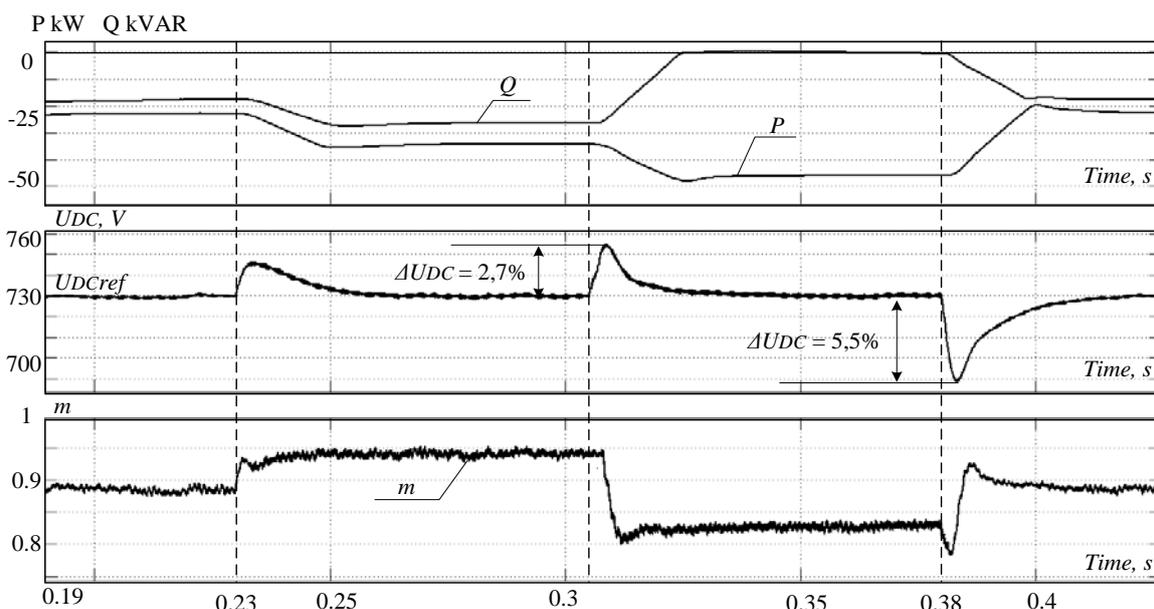


Fig. 4. Curves of transients of the electric generator mode when operating PWM boost rectifier with $\cos(\varphi) = -0.8$.

In the time period from $t_0 = 0.19s$ to $t_1 = 0.23s$ the process of operating PWM Boost rectifier with consumed (Fig. 3) and generated (Fig. 4) rated active power is simulated. DC voltage is supported at the reference level. PWM Boost rectifier operates with $\cos(\varphi) = -0.8$.

Since the time of $t_1 = 0.23s$ to $t_2 = 0.305s$ the consumption (Fig. 3) and the generation (Fig. 4) of active power is one and half increased. This leads to the dynamic voltage dip by 3.4% (Fig. 3) and overvoltage by 2.4% at the DC bus (Fig. 4). Then DC voltage is maintained at the reference level. PWM Boost rectifier operates with $\cos(\varphi) = -0.8$.

Since the time of $t_2 = 0.305s$ to $t_3 = 0.38s$ the consumption (Fig. 3) and the generation (Fig. 4) of active power is twice increased. This leads to the dynamic voltage dip by 2.3% (Fig. 3) and overvoltage by 2.7% at the DC bus (Fig. 4). Then DC voltage is maintained at the reference level. PWM Boost rectifier can no longer generate reactive power, because of limitations on the overload capacity. Reactive power controller reduces the magnitude of generated reactive power to zero. PWM boost rectifier operates with $\cos(\varphi) = 1$.

Conclusion. The analysis of the results revealed, that when working PWM boost rectifier with maintaining power factor on level -0.8 maximum, power consumption of the drive is reduced by 25%, because of limitations of the current converter. To ensure maximum load of electric drive when working PWM boost rectifier with the power factor equal to -0.8, the authors propose a reactive power controller in the channel regulation of reactive current, which limits the amount of generated reactive power at the maximum load of electric drive.

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J11510-014

Mikhalevskiy D., Huz M., Krasota R.
THE TRANSFER OF THE TRAFFIC IN A WI-FI NETWORKS WHILE
NOISE INTERFERENCE INFLUENCES

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Annotation. In this paper was studied the characteristics of the traffic by the action of noise interference in Wi-Fi network.

Key words: traffic, noise interference influences, network of Wi-Fi.

Introduction. One of the main tasks of modern facilities for the traffic transmission using the wireless channel is to provide high throughput for a single subscriber. Tools for high speed transmission are being continuously improved as the amounts of information are growing. But this process is simultaneously accompanied by the constant presence of random noise in the transmission medium. Such interference is generally difficult to predict and impossible to offset. But there are many techniques that can reduce their impact [1]: usage of excessive coding, adaptive equalization delays, usage of diversity methods, spread spectrum techniques and others.

Considering the wireless network 802.11 Wi-Fi, it can be said that, as the study showed [2], the main obstacles in the channel was interference noise. Therefore, in this paper we will try to consider the characteristics of the traffic in terms of noise interference, as one of the main factors that particularly affect the value of the effective speed of information transmitted via a wireless channel 802.11n.

Main part. In general, interference is the appearance on the receiver antenna as a wave of direct visibility from the transmitter and the reflected waves from interference with offset phases.

For networks 802.11 Wi-Fi interference noises can be divided into two groups: interference created by other transmitters of the same standard and receiver noise standards and other household devices (usually they are referred to noise).

The nature of the noise impact of the second group can be explained in studies in [3]. When there is narrowband interference noise in a transmission medium, energy efficiency increases signal using spread spectrum techniques for channels in the unlicensed frequency band 2.4 ... 4,483 GHz. It also provides high noise immunity to radio interference with other narrow band. The other situation consists of broadband noise presence. Power of such noises increases proportionally to the bandwidth of the signal. So, in this case, such interference may include other standards of transmission system with wide channels and interference of the first group using spread spectrum techniques.

The noise of the first group will make the greatest impact on the effective bandwidth. Let's try to assess such effects for networking standard 802.11 Wi-Fi. The network was constructed as shown in Figure 1.

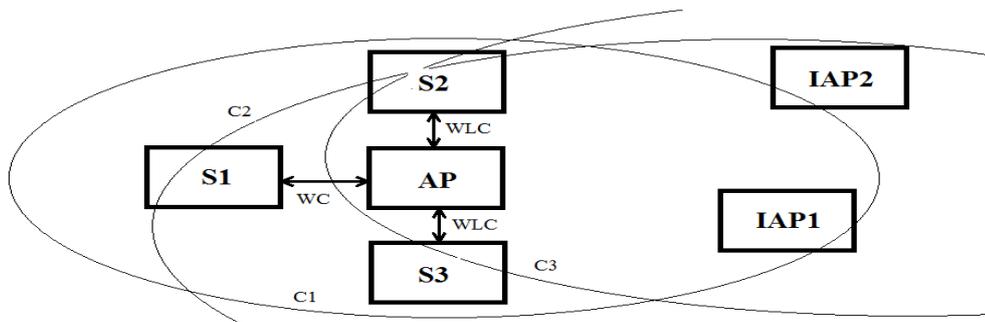


Fig. 1. Research network scheme

Methods of research are the next. There is 802.11n wireless network based on router access point (AP) which provides cover C1. In this network are: one subscriber (S1) with wired channel (WC) to AP and two subscribers (S2, S3) with wireless channel (WLC). In addition to introducing noise was created two networks with interference access points (IAP1, IAP2) coated C2 and C3, respectively.

To assess the impact of interference noise parameters of wireless channel we shall set two cases: TD frequency channels do not overlap; using the same frequency channel so that the main lobes were crossing [4]. Thus, the frequency spectra were obtained as shown in Fig. 2.

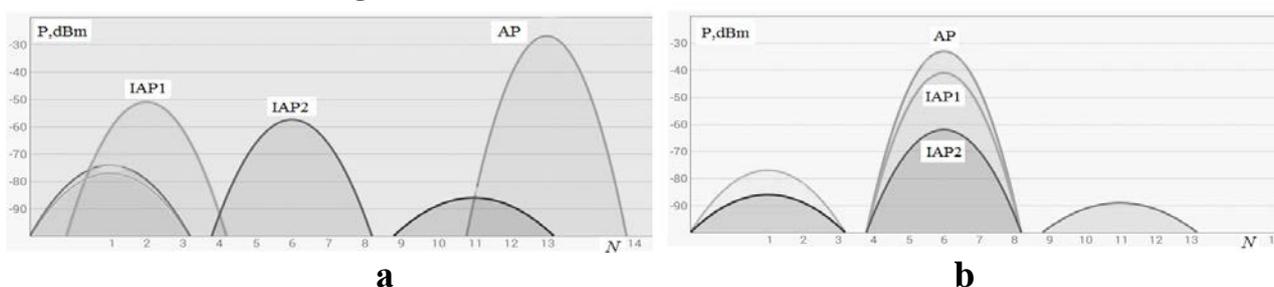


Fig. 2. Frequency spectrum where: frequency channels do not overlap (a); using the same frequencies channel (b)

Fig. 2 shows the frequency spectra for 20 MHz wide channels. Similar operations were performed for bandwidth of 40 MHz. The main investigated parameter was used effective information rate V , as for receiver channel (r_c) and for transmitter channel (t_c), which is dependent on the power of the received signal and the distance between the transmitter and receiver.

At first, consider the information channels S1-S2 – using the single channel for wireless access point (see. Fig. 1). The research results are presented in Figure 3.

Next, we will consider the transmission channel created by S2 and S3 subscribers – using two wireless channels for access point. In this case, the research results shown in Figure 4.

Conclusions

Thus, analyzing the results of the study we can make the following conclusions.

1. The data transfer speed for two mobile subscribers to the same access point, less than an average of 80% with respect to the one.
2. Under the influence of interference noise channel with 20 MHz bandwidth, there was an increase transfer rates of 1-2 Mbps than in conditions without interference. This is particularly observed when a subscriber at a distance of 12-16m

from the access point. This effect may be caused by multipath propagation of waves in a room that needs some research.

3. For the channel with 40 MHz bandwidth was observed relative stability parameter channel with a slight decrease to 1 Mbps by the influence of interference noise.

Thus, in general, the transmission channel with greater bandwidth is more resistant to interference and noise interference from multipath propagation.

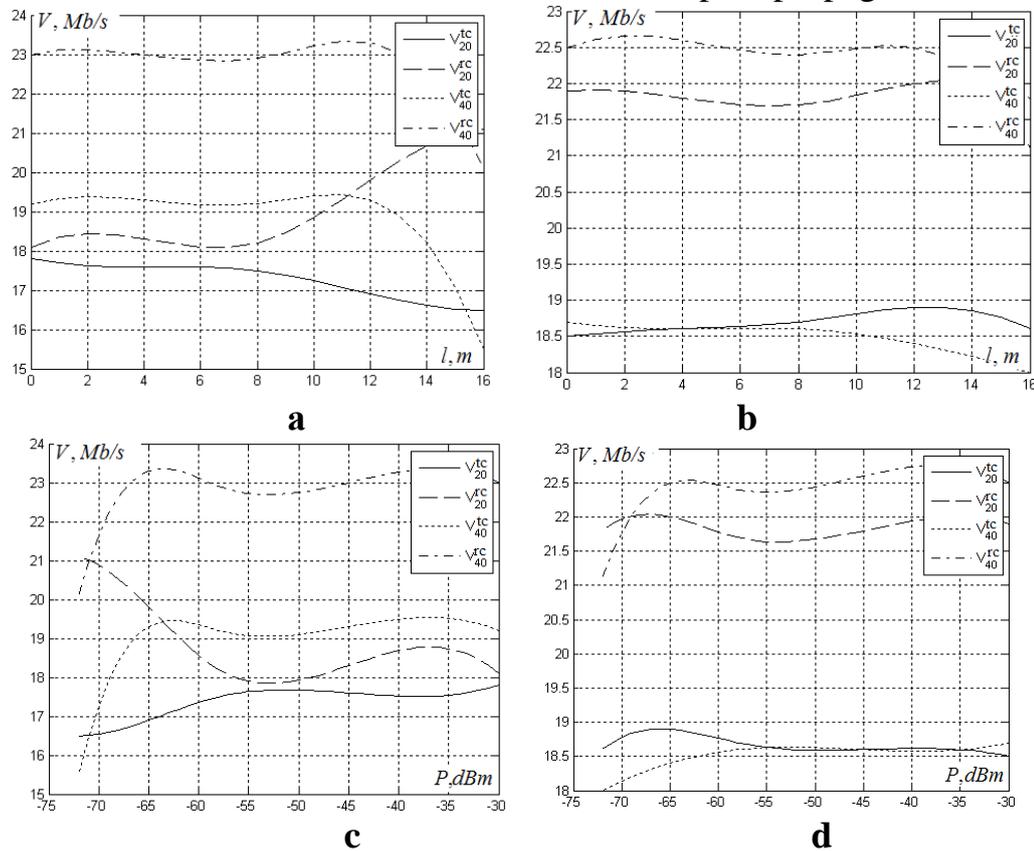
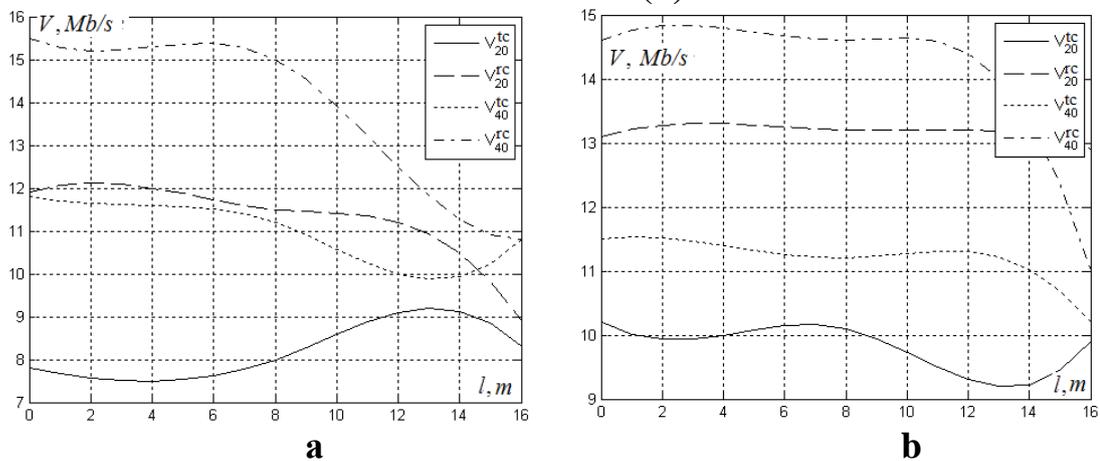


Fig. 3. Dependence of the rate for the transmission channel S1- S2 from: the distance between the transmitter and receiver without interference noise (a); the distance between the transmitter and receiver with interference noises (b); received signal power without noise interference (c); received signal power with noise interference (d)



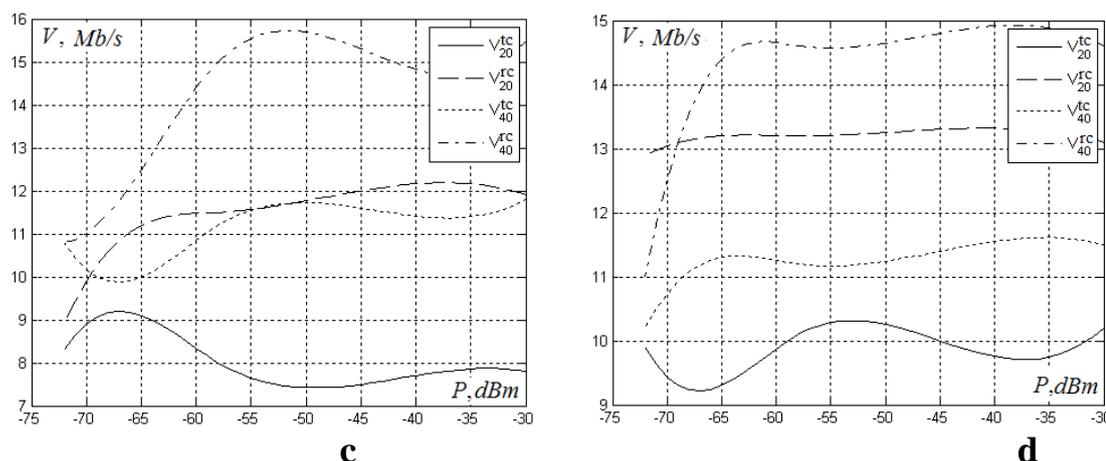


Fig. 4. Dependence of the rate for the transmission channel S2- S3 from: the distance between the transmitter and receiver without interference noise (a); the distance between the transmitter and receiver with interference noises (b); received signal power without noise interference (c); received signal power with noise interference (d)

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J11510-015

Savenkov G.G.¹, Morozov Y.V.¹, Razinkin V.P.¹, Tsykunov A.V.²
3-WAY UHF POWER DIVIDER

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Abstract. In this paper we consider a three-way power divider based on two-way dividers. Computerized simulation of this divider has been made. The investigated divider will be applied in TV transmitters.

Key words: testing, code modulator, generator of functions.

Power dividers and adders are widely used in various UHF devices. Power dividers distribute input power between several output ways. Depending on application area power dividers provide balanced or unbalanced power division by two or more.

Multi-way power division and addition systems can be compounded of two-way power dividers [1] of any type. To design the three-way power divider the serial connection circuit of two-way dividers [2] has been chosen (fig. 1).

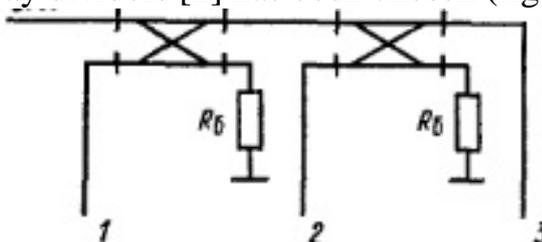


Fig.1. 3-way power divider circuit

The developed divider has to provide balanced signal distribution among three ways. Hence the first two-way divider output power should be $2/3$ of input power. $1/3$ of power goes to the tap 1. The second two-way divider provides balanced power division by two.

The divider operation mode has been designed with the computer simulation (fig. 2-6).

The first two-way divider characteristics are operation fading and coupling attenuation.

Operation fading is

$$C_{12} = 10 \lg(P_{in} / P_{out}) = 10 \lg\left(P_{in} / \frac{2}{3} P_{out}\right) = 1,76 \text{ (dB)} \quad (1)$$

Coupling attenuation is

$$C_{13} = 10 \lg(P_{in} / P_{tap}) = 10 \lg\left(P_{in} / \frac{1}{3} P_{in}\right) = 4,77 \text{ (dB)} \quad (2)$$

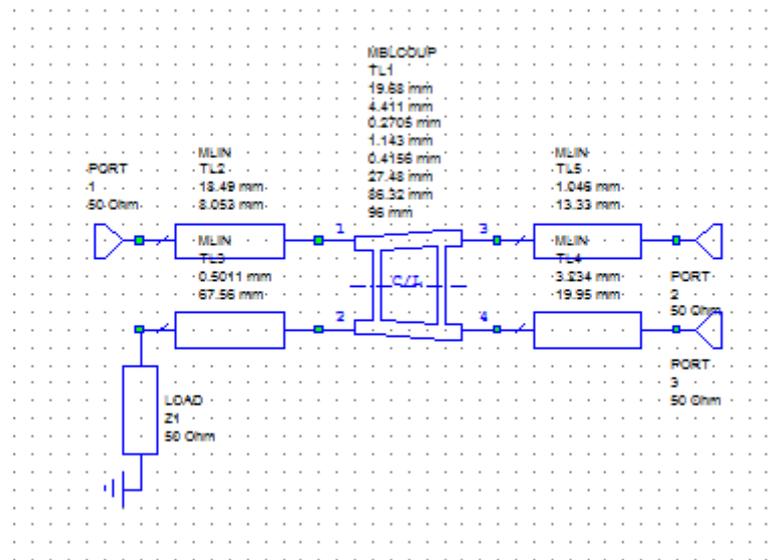


Fig. 2. First two-way divider model

The operation fading is inversely proportional to the factor S_{12} . S_{12} (dB) or it is equal to the factor S_{12} (dB) with inverse sign: C_{12} (dB) = - S_{12} (dB). The values S_{13} and S_{12} are connected with the similar equation: C_{13} (dB) = - S_{13} (dB).

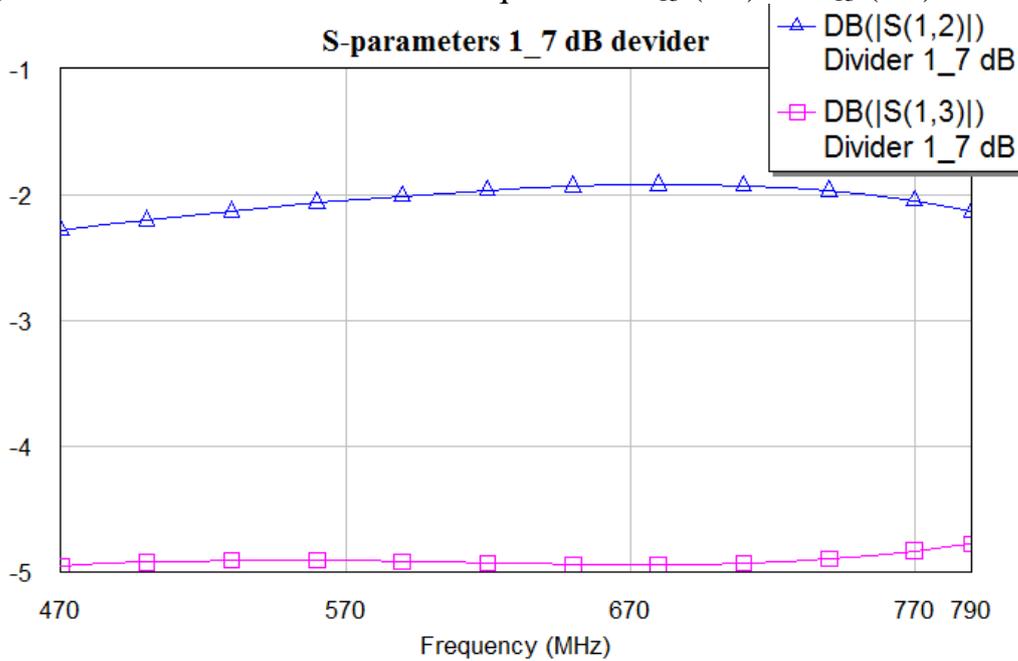


Рис.3. S-parameters of the first two-way divider

The second two-way divider characteristics are:

$$C_{12} = C_{13} = 10 \lg \left(P_{in} / \frac{1}{2} P_{in} \right) = 3 \text{ (dB)} \tag{3}$$

The three-way divider provides the balances division by 3. It should have the following characteristics:

$$C_{12} = C_{13} = C_{14} = 10 \lg \left(P_{in} / \frac{1}{3} P_{in} \right) = 4,77 \text{ (dB)} \tag{4}$$

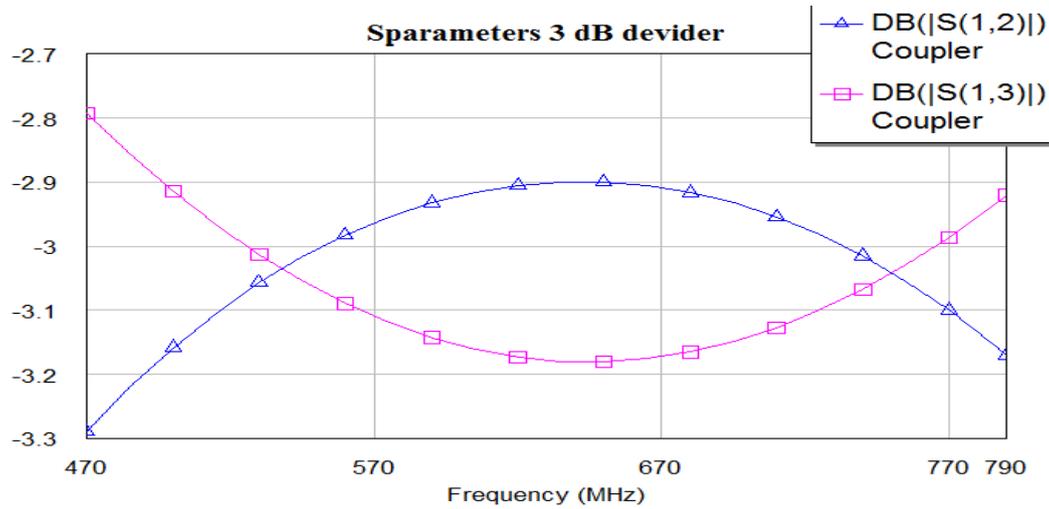


Fig.4. S-parameters of the second two-way divider

The three-way divider circuit based on the connected in series two-way dividers is stated in fig. 5.

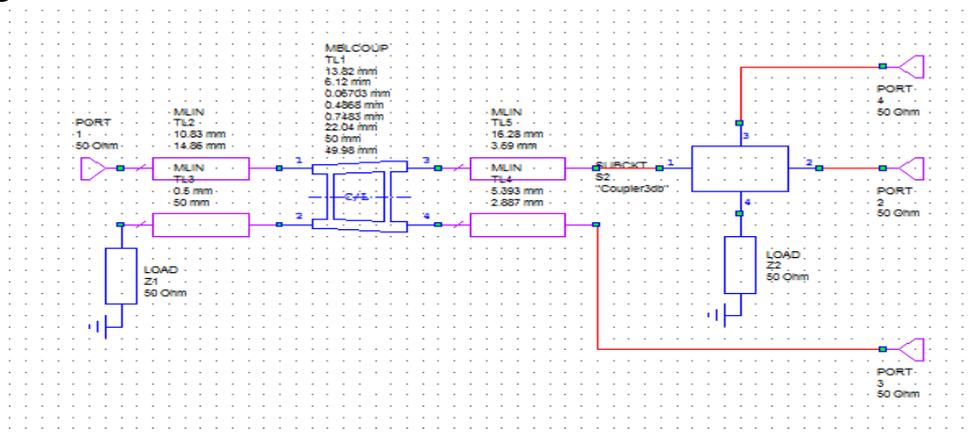


Fig. 5. Three-way power divider model

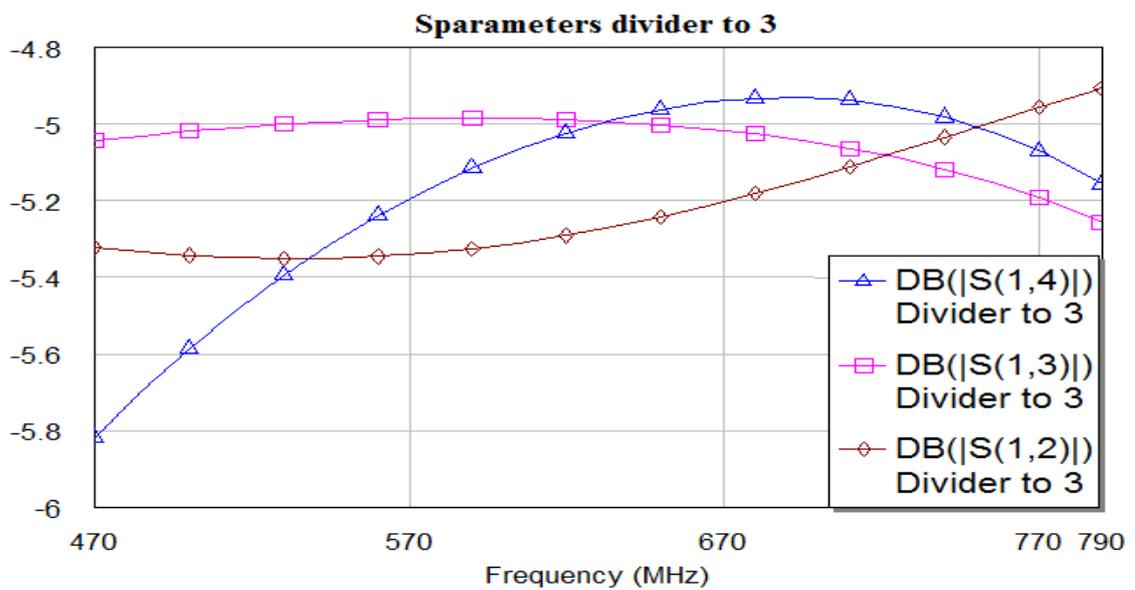


Fig. 6. S-parameters of the three-way power divider

Therefore the three-way power divider consisting of two connected in series

two-way power dividers. The proposed structure meets the demands to it and provides balances input power distribution among three output channels in the wide frequency range.

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J11510-016

Tyulevin S.V., Piganov M.N., Mishanov R.O.
**DEVELOPMENT DIAGNOSTIC METHODS FOR NON-
DESTRUCTIVE CONTROL CHIP**

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The technique of diagnostic control and rejection of potentially unreliable chip 286. As a series of informative parameters used in certain areas and the type of the return branch of the current-voltage characteristics, and the dependence of the leakage current from the output voltage.

Keywords: non-destructive testing, methodology, automated device, diagnostics, chip, rejection, informative parameters, current-voltage characteristic.

Diagnostic non-destructive testing of components of electronic components with subsequent rejection of potentially unreliable samples increases the reliability of on-board equipment.

The selection of informative parameters

Integrated circuits series 286 contain two made on a separate crystals bipolar structure, consisting of a large number of enabled parallel unit cells with diffusion resistors in circuits emitters to equalize the power distribution area.

A large number of unit cells can not cause a variation of their parameters, primarily nominal equalizing resistors. In addition, the increase in the area of the crystals to obtain a large capacity increases the probability of activation of defects (microcracks, dislocations, clusters, violations of the doping profile, dirt surface).

These structural and technological features and defects can lead to heterogeneity produced and avalanche breakdown, lower electric strength, local overheating, increase leakage currents.

These phenomena manifest themselves in changes in the shape of current-voltage characteristics under reverse bias p-n junctions. So technology violations and defects associated with the increased concentration of impurities lead to a "soft" form of the return branch of the CVC or "runaway" VAC (Pic. 1,a and b). "Microplasma" low-voltage breakdown indicates the presence of microcracks, dislocations and defects planting (Pic .1,c).

The emergence of end-to-end channel when the $U_{\text{threshold}}$ indicates the contamination of surface and protective coating (Pic. 1,d).

The presence of moisture and dirt on the surface of the molecule which is able to polarize, leads to the formation of hysteresis I-V characteristics (Pic. 1,e).

Thus, the type of the return branch of VAC of p-n junctions of the transistors included in the IMS series 286, is informative regarding the listed defects and can be used for diagnosis and rejection of potentially unreliable instances.

In developing the methodology of DNA IC 286EP characteristics were investigated under reverse bias input and output circuits of a compound of transistors in the shoulders microassembly.

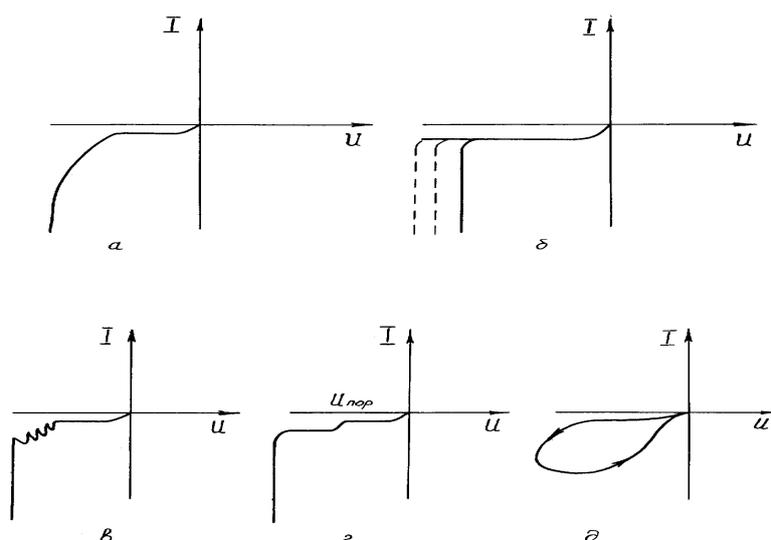
Studies have shown that the most significant variation in importance values of

leakage current due to reverse currents transitions collector-base takes place in the output circuits of the composite transistors IMS /12/. Pictures 18, 19, 20 present the histogram of the distribution of values $J_{\text{leak out}}$ for samples $n_1 = n_2 = 50$, respectively, for the left (l) and right (r) in the electric circuit of the composite transistors IMS EP when a reverse voltage equal to the maximum allowable in TU one as well as the distribution of the sample formed by their summation. The presence of the "tails" of the distributions indicate the presence in the samples of IMS with abnormal characteristics.

From the histograms it is shown that the statistical distribution $J_{\text{leak out}}$ has almost the same shape regardless of belonging to a particular shoulder under the scheme, due to uniform distribution of crystals on substrates. This determines the need for a separate diagnosis for each of the components of the double-crystal transistors microassembly.

Similar results were obtained for IMS 286 EP for samples $n_1 = n_2 = 45$ /13/.

These considerations led to the choice as informative parameter VAC output circuits $I_{\text{leak out}} = f(U_{\text{out}})$ when reverse bias.



Pic. 1. Volt-ampere characteristics of p-n junctions under reverse bias

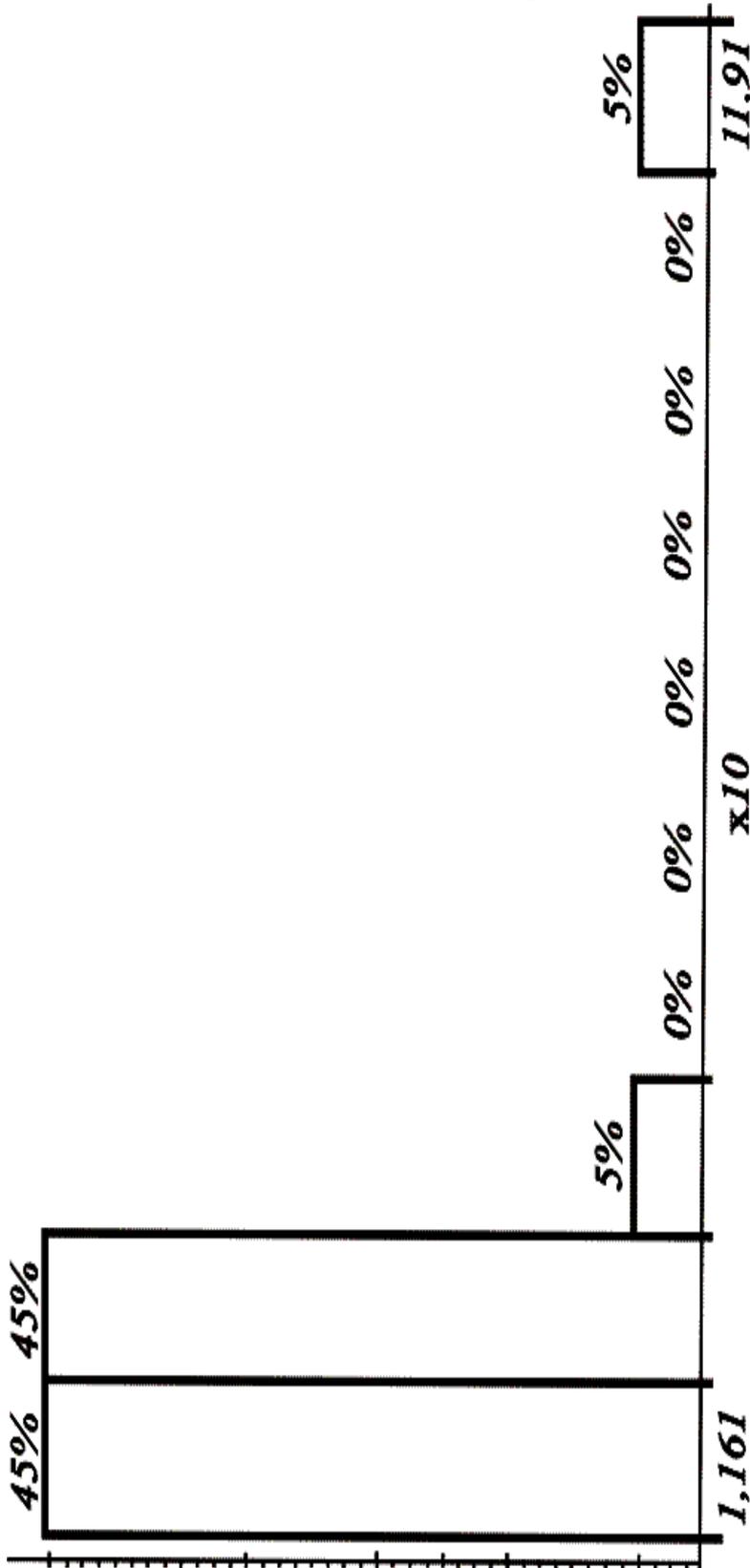
The definition of the base areas VAC

To determine the base regions was formed sample IMS 286 IP1 of volume $n = 25$ pieces, increasing the sample size on composite transistors to $n_2 = 50$. For all instances of the samples were measured VAC characteristics $J_{\text{leak out}} = f(U_{\text{out}})$ in each of the shoulders of the valves in the reverse range of offsets from zero to 90 V with increments of 10 V. Several exceeding the maximum allowable voltage is the need for the provision of call in predproboinoe region.

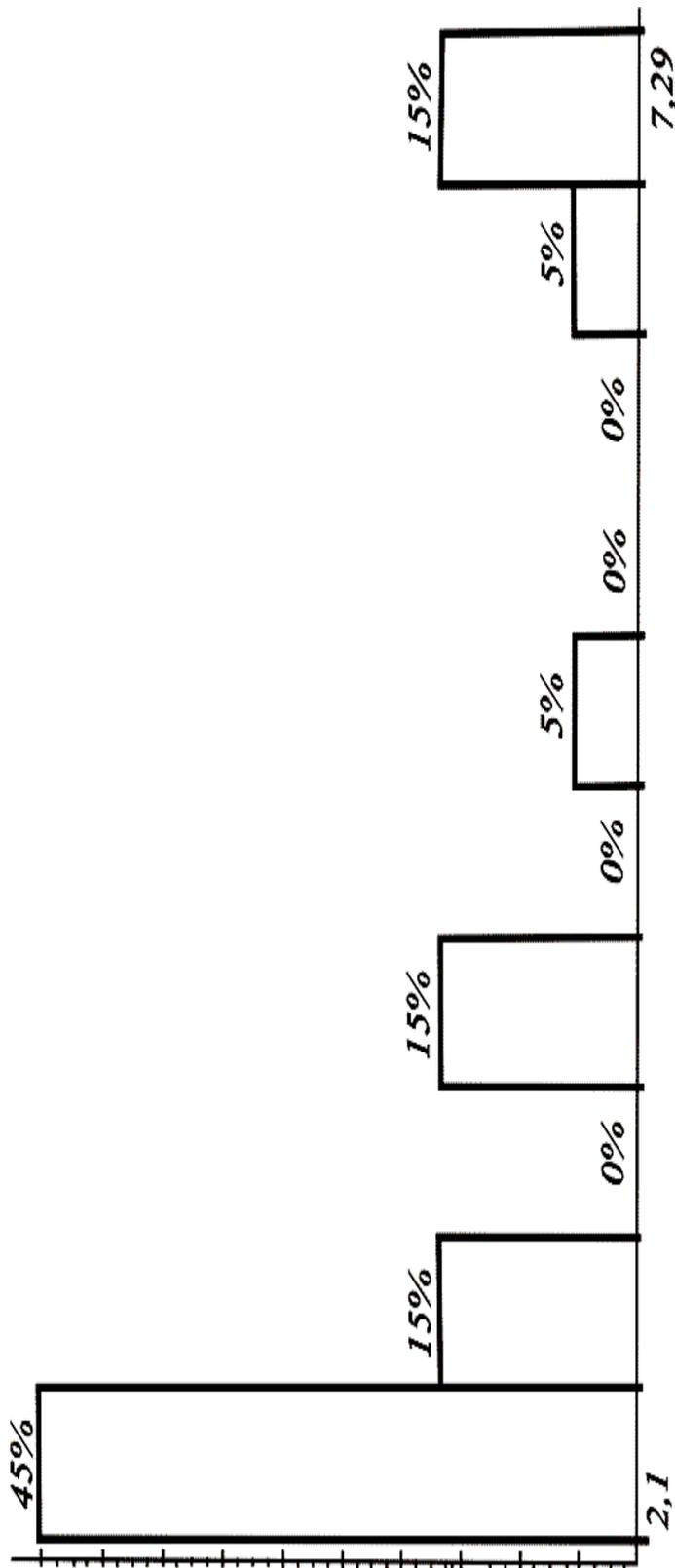
At each point of the VAC there were determined the values of mathematical expectation $M[J_{\text{leak out}}]$ and the mean and standard deviation $S[J_{\text{leak out}}]$ of leakage current.

Instances with sharply different from the typical values of the leakage currents

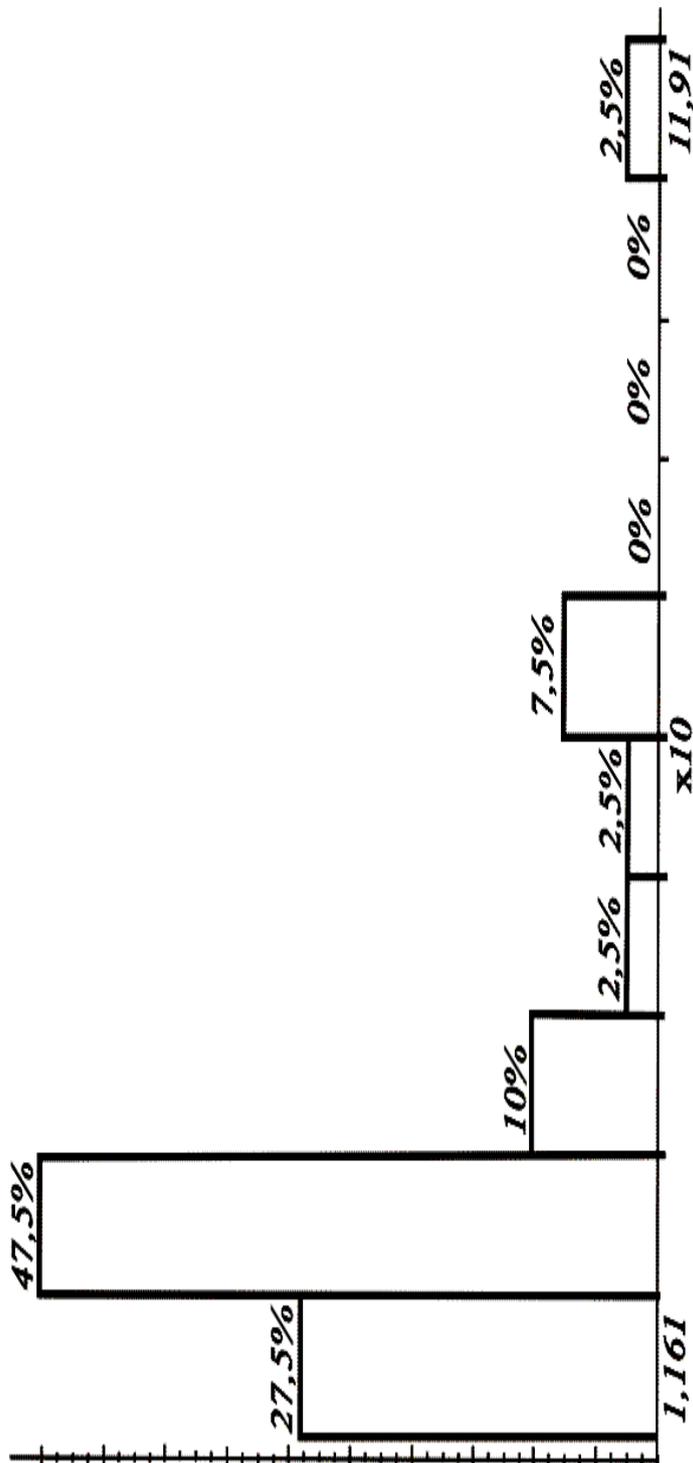
from the selection by statistical processing were excluded



Pic. 2. The distribution of $I_{peak out}(Uout=Uoutpr)$ IMS
286 EP(1) n=50



Pic. 3. The distribution of $I_{leak\ out}$ ($U_{out}=U_{outpr.}$) IMS 286EP1(II) $n=50$



Pic. 4. The distribution of $I_{leak\ out} (U_{out}=U_{outpr})$ IMS 286EP1

To build the base area at each point calculated field tolerance 3S and for tighter control, 2S on the border.

Thus, were built upper (UB) and lower (LB) border base areas for different degrees of stiffness control.

On picture 2.12 there is shown the graphs corresponding to the boundaries of the underlying zones for 3S and 2S tolerance to the expected leakage current, as well as limiting cases of type VAC in the studied sample. On picture 2.13 there is shown the same dependence for the IMS 286 IP3.

During the rejection of potentially unreliable IMS, the last control on TU, the lower bound has no meaning and is not used. The position of the upper boundary is adjusted on the results of field and laboratory testing the IC on reliability, durability, or other indicator of reliability.

In this case, for accelerated testing to adjust the boundaries of the base area is set more narrow field of tolerance parameters-criteria of suitability (PCS) of IMS. As IMS286IP1 PCS were taken leakage current value $J_{\text{leak out}}$ composite output circuits of transistors assemblies with a maximum allowable voltage across U_{outpr} .

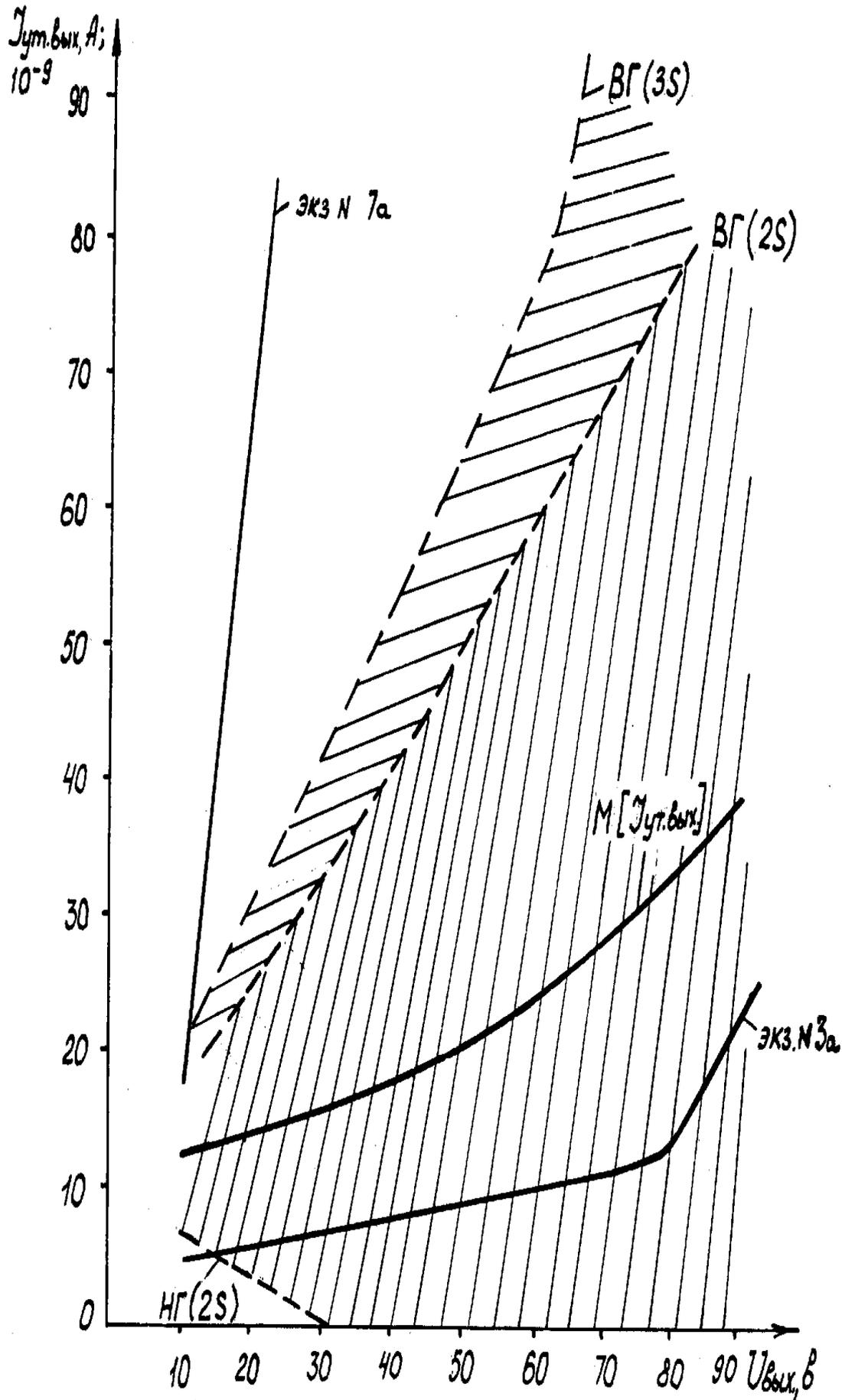
When choosing equipment taken into account the following requirements:

- automation of the measurement process of VAC;
- automate the processing of its results;
- automation of decision-making about the level of potential reliability of the IMS;
- automation of documentation of testing results;
- the combining operations diagnostic control parameters on TU on one computer with a single installation of the IMS in the adapter.

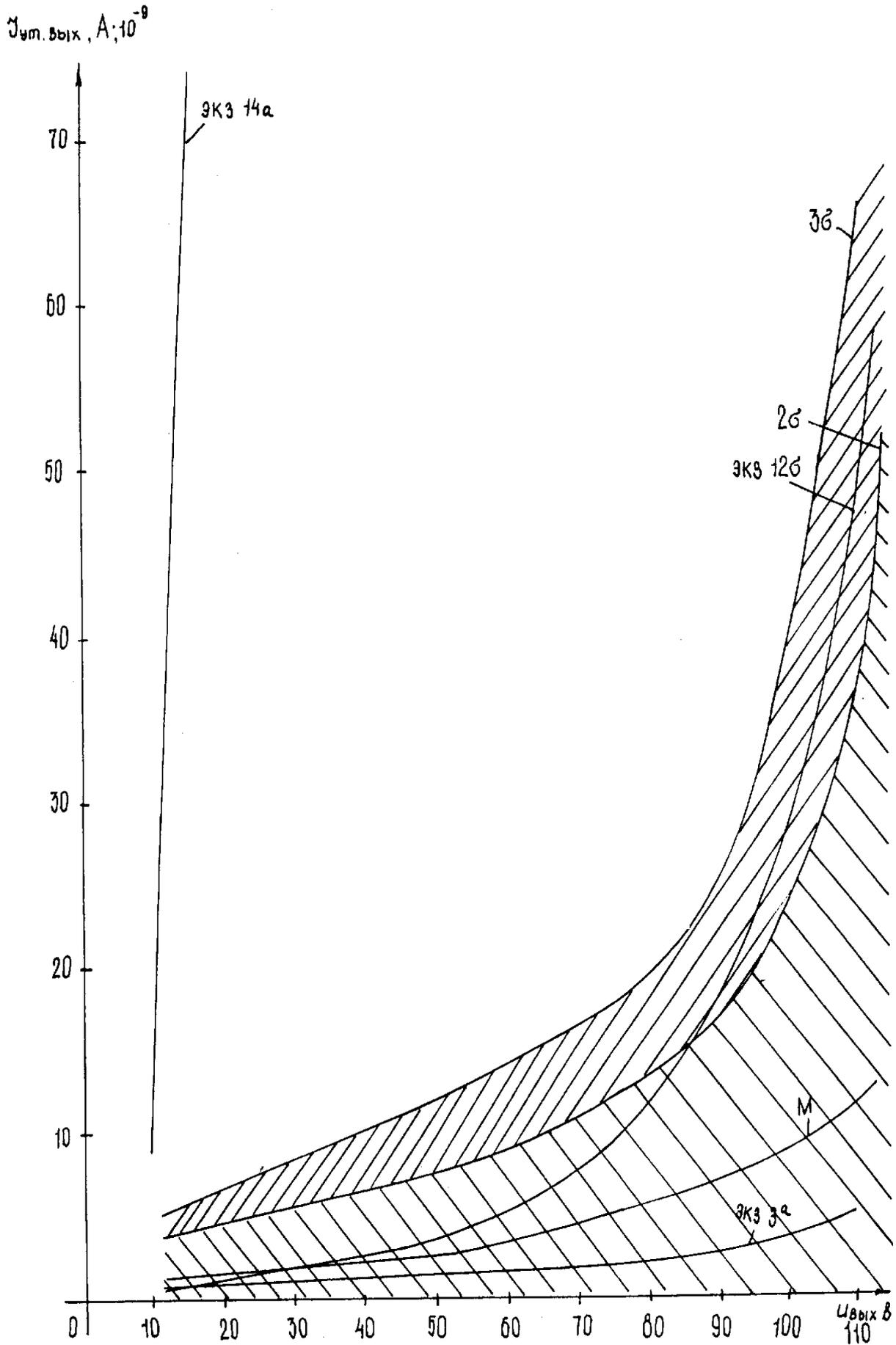
According to these requirements there was used the automated tester 14TKS-100-001, for which the corresponding program testing the software.

Conclusion

Developed a method non-destructive testing of diagnostic chips Series 286. It is based on the feedback control of the CVC and leakage current.



Pic. 5. The base area of VAC of IMS 286IP1



Pic. 6. The base area of VAC of IMS 286IP3

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J11510-017

Kulikov R.Ye.

MATHEMATICAL MODELS OF THE DESCRIPTION OF STRUCTURES OF CONTROL SYSTEMS

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Introduction. The diagnostic model [1] represents the formal description of the equipment of technical systems considering possibility of change of its state over time.

Due to the large number of various devices of such systems as to destination, to the modes of use and operation, and by the principles of construction and a design by developers of diagnostic providing the set of various diagnostic models is applied.

We will consider models of the description of systems of a type of systems of the equations and the logical directed graph.

Analytical models. Analytical models [2, 3] represent the mathematical ratios characterizing processing equipment at change of its state. Coefficients of these ratios show interrelation of the external measured parameters of system with its internal characteristics. Extent of change of pictures of static and dynamic characteristics allows to judge existence and nature of refusals in the equipment.

The most widespread models are the differential equations or the transfer functions of system or elements of system [2] received on their basis:

$$W(p) = \frac{b_m p^m + b_{m-1} p^{m-1} + \dots + b_1 p + b_0}{a_n p^n + a_{n-1} p^{n-1} + \dots + a_1 p + a_0}, \quad (1)$$

where $a_i, i = 0, 1, 2, \dots$ and $b_i, i = 0, 1, 2, \dots$ are constants; $p = \frac{d}{dt}$ is operator of differentiation.

In expression (1) the ratio has to be carried out: $m < n$.

Analytical methods allow to use convenient ways of optimization during the analysis and to receive the corresponding mathematical ratios expressing laws of functioning of the devices described by them. These methods are effective at research of any diagnostic models and are characterized by depth and completeness of their descriptions. However consideration of models of systems in an analytical form has a number of shortcomings. First, modern elements of control systems of processing equipment are difficult, in many cases nonlinear. When carrying out their linearization the part of data on laws of management that corresponds to small accuracy on an output can be lost. Secondly, in the presence in difficult systems of interchannel communications there are difficulties in the analysis of structure of the device, proceeding from a type of analytical models [4, 5].

Graphic-analytical models. At creation of models of difficult systems use of the device of graphic-analytical models, including in a case when analytical models are unknown [2] is rational. Advantages of graphic-analytical models are: presentation of display of structures of systems; opportunity to consider influence of components of systems on conditions of output. Basic data for synthesis of graphic-

analytical models are block, function, electric, schematic diagrams of systems, the algebraic, differential equations, and also cause-effect relationships between parameters of systems in relation to specific objectives in engineering practice.

The directed graph is couple $G = (A, C)$, consisting of a set of A tops and a set of the C edges tied by the incidence relation. Thus the directed graph allow to receive one of the most evident displays of mathematical models.

Difficult control systems are characterized by the difficult organization of interrelations of information ways in structure of systems from input to output, are multipurpose and are described by sets of values of output parameters in multidimensional parametrical space. At structural modeling of difficult systems the mathematical apparatus of the theory of graphs is often applied. It is necessary to consider that the traditional mathematical graph apparatus has insufficiently extensive arsenal of means of the description of diverse properties of difficult systems and their components. Therefore modeling of such systems means of tops and edges of graphs becomes complicated, and, therefore, the last complicates practical use of mathematical apparatus of the theory of graphs to real systems.

The defect of the ordinary directed graphs given above in many respects is eliminated when using mathematical apparatus of the logical directed graphs which allows to describe at the same time structure of tops and the graph's edges, and also various and diverse properties of tops and the graph's edges in practice, thereby considerably enriching possibilities of modeling of real systems [6, 7]. Thus possibility of identification of efficient components from disabled by means of model of the diagnosed system is reached.

As means of synthesis of model of a control system it is applied logical directed graph $G(B, E) |_{\{\theta\}}$ which basis of construction is the experimental and analytical method. Thus the set subset of tops of the graph $(B(b_1, b_2, \dots, b_k))$ corresponds to the list of functional components of the device $(K(k_1, k_2, \dots, k_k))$, and a subset of edges (the directed arches) between the graph's tops $(E(e_1, e_2, \dots, e_l))$ reflects information structure of system. The arrangement of set of tops of the graph (B) is defined by the set functions of components of a control system (K) which are carried out in structure of system according to known laws of management and algorithms of functioning. Set of edges (E) emphasizes the topological and functional communications set by the relevant laws of management and algorithms of functioning of system.

For example, the edge directed from b_i top to b_j top and further from b_j top to b_k top when functioning top will exist in case b_j and b_k tops participate in realization at least of one elementary function executed by b_j top. Therefore, the directed edges unite adjacent couples of components and specify the admissible directions of flows of information.

The set subset of logical conditions $(\theta(\theta_1, \theta_2, \dots, \theta_i))$ defining process of

execution of the algorithms of functioning reflecting various modes of functioning of object according to requirements of specifications of system is of special interest. The list of logical conditions on concrete a control system regulates passing of signals from inputs of system to its output, that is defines structure information-significant input-output functional dependences. Passing of information on input-output of components in structure of system is defined by logical functions "AND", "OR".

The logical directed graph representing initial model of a control system is formed on schematic and function charts, taking into account design documentation on system, the concrete modes and procedures of functioning of system. Process of the organization of initial structure of model of system across (levels) and on verticals (information ways, independent channels) and an order of its optimization provides possible realization for each top (component) at least of one elementary control and diagnostic experiment in turn finding deviations from operating technical states for separate functional components of a control system.

In **fig.1** the fragment of model of representation of the device of a control system is presented in the form of the logical directed count. Here tops $(u_1 - u_4)$ correspond to the main input control points in relation to the object used for designated purpose; tops $(y_1 - y_5)$ reflect the main output control points involved at application of object on purpose. Outputs $(y'_6 - y'_9)$ are additional control points of a system of diagnostic information. Points $(y'_6 - y'_9)$ can be also used in the processes of the analysis of object or its control for data acquisition characterizing required conditions of object of diagnosing. It is also necessary to note that outputs $(y'_6 - y'_9)$ can be used as additional input control points at procedure of the analysis and recognition of necessary conditions of system. In **fig.1** logical functions "AND", "OR", information defining passing on input-output of components in structure of system, are noted. Logical conditions $(\theta_1 - \theta_5)$ define process of execution of according to requirements of technical documentation of system.

In this statement there are four types of information communications: a main input with a component input; a component output with the main output; a component output with a component input in the direction of information stream; a component output with a component input against the direction of information stream (feedback).

The method of the organization of structure of model of a control system provides procedure of transformation of model as means of its simplification (optimization). Optimization of model is necessary for the best formalization of laws of management and processes of functioning of system, and also recognition of the reasons of decrease of reliability of components of system and system in general. Practically simplification of the logical directed graph is reached due to identification of characteristic subgraphs, streamlining and the analysis of information ways and allocation of independent channels generally with n-main inputs, one (set) the main output and additional outputs [7].

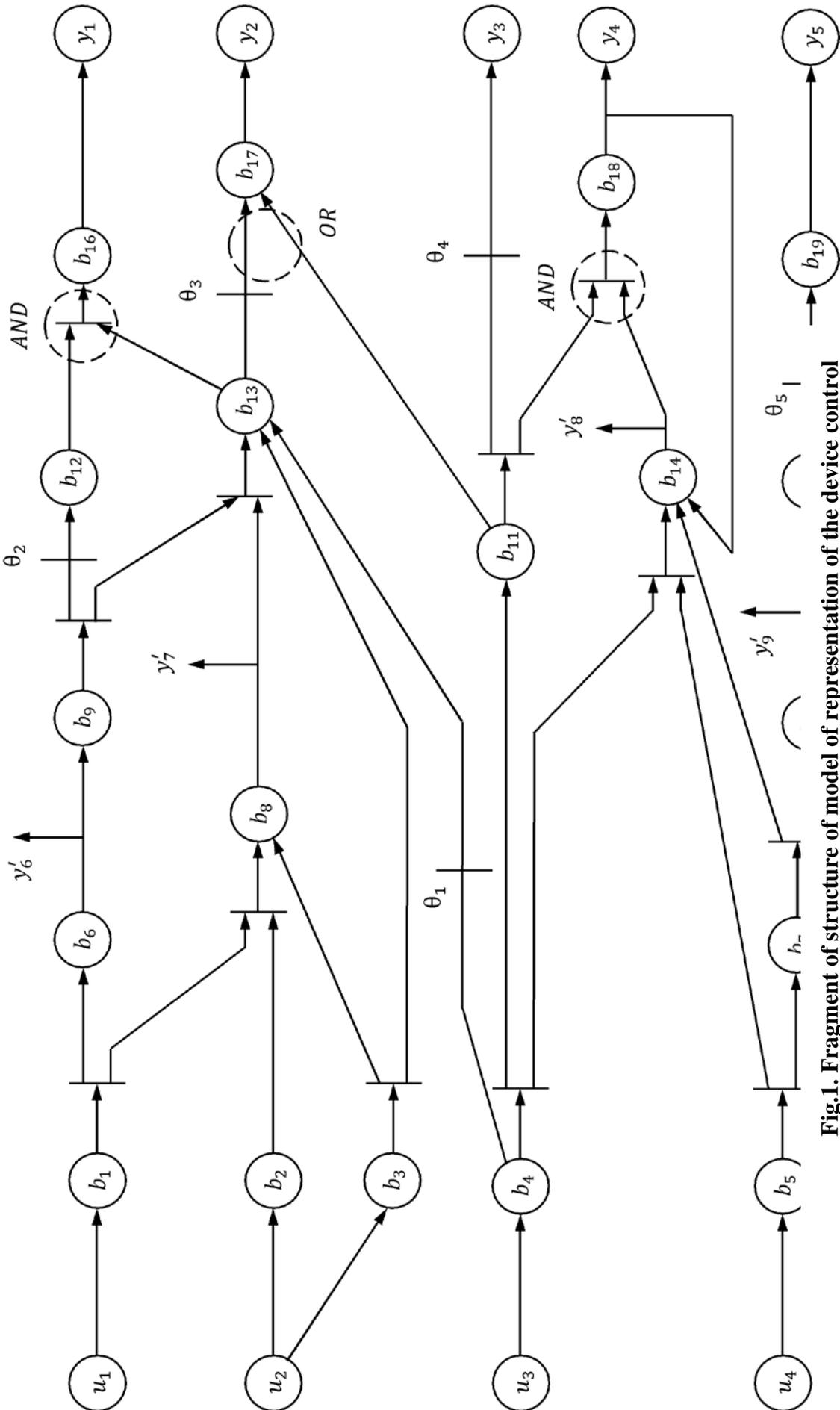


Fig.1. Fragment of structure of model of representation of the device control systems in the form of the logical directed graph

algorithms of functioning taking into account various modes of functioning of system

It is necessary to emphasize that the order of passing of information at the organization of control and diagnostic experiments, owing to the structurally functional organization of model of system, can be defined by the final list of conditions of the transitions providing functioning of system, logic of set of information ways.

The logic of possible information ways is clear from the maintenance of **fig.2**. In **fig.2, a** it is visible that on the appropriate information ways from b_i, b_j tops data on b_k top in the presence of conditions θ_l arrive. From b_k top information can arrive on b_i, b_j tops in the presence of conditions θ_l and when performing logical function "AND" (**fig.2, b**). The b_k top obtains data from b_i, b_j tops in the presence of conditions θ_l, θ_m (**fig.2, c**). The b_k top issues data on b_i, b_j tops in the presence of conditions θ_l, θ_m and when performing the logical "OR" function (**fig.2, d**). The b_i top receives information when performing a logical condition "AND" (**fig.2, e**). The b_i top receives information when performing a logical condition "OR" (**fig.2, f**).

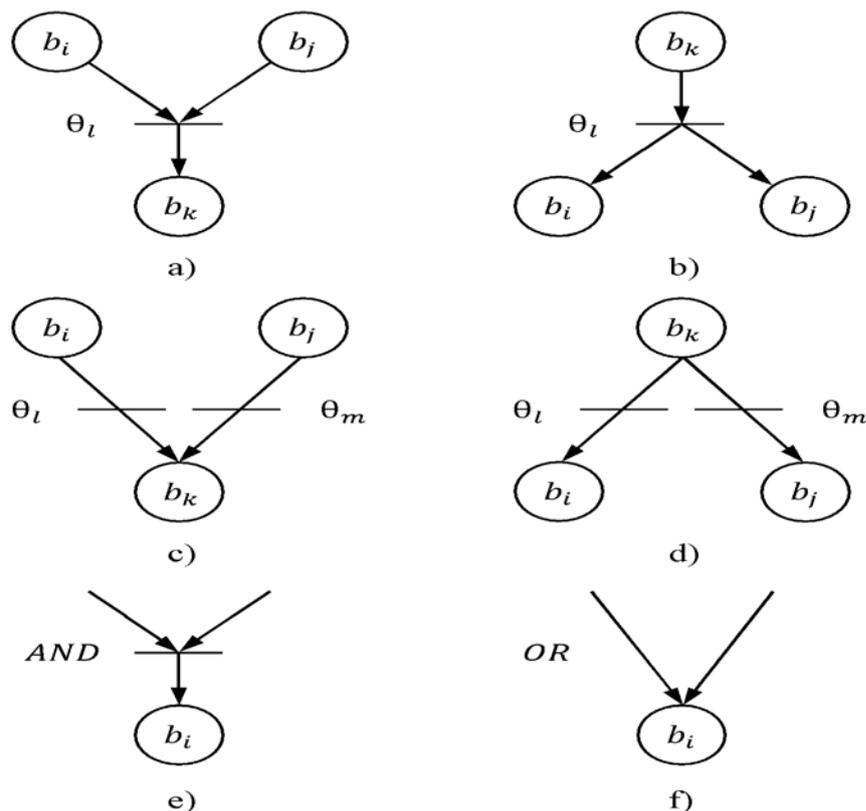


Fig.2. Functional and logical conditions of passing of information (data) in structure devices of control systems for various cases of the organization of communications: a) b_i, b_j, b_k are tops of the logical directed graph, conditions θ_l ; b) logical function "AND", conditions θ_l ; c) conditions θ_l, θ_m ; d) logical function "OR", conditions θ_l, θ_m ; e) logical function "AND"; f) logical function

"OR"

The logical conditions and restrictions considered on **fig.2** can be applied to mutual isolation of the interconnected information ways by imposing of restrictions on adjacent edges of subgraphs taking into account the set modes of functioning of system.

The subset of refusals of components of control system $Q = \{Q_1, Q_2, \dots, Q_k\}$ can be identified with set of tops of final structure of the model presented by the logical directed graph $G(B, E)|_{\{\theta\}}$ [6, 7].

Conclusion

At the description of structures of difficult control systems it is expedient to present initial model of a control system in the form logical directed graph $G(B, E)|_{\{\theta\}}$, where $\{B\}$ is the final subset of tops of structure of model corresponding to the list of components of system; $\{E\}$ is the final subset of arches of model reflecting information structure of input-output functional dependences of components of system and system in general; $\{\theta\}$ is the subset of logical conditions reflecting algorithms of functioning of system at its various modes of functioning. Models in the form of the directed logical graph allow to describe structure of the device of a control system, interelement communications, control channels, to identify faulty elements in processes of technical diagnosing of equipment failures.

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INNOVATIVE USE OF INFORMATION, DISTANCE EDUCATION AND MODERN MULTIMEDIA IN THE EDUCATIONAL PROCESS*National Technical University of Ukraine "Kyiv Polytechnic Institute"**Kyiv, Prospect Pobedy 37, 03056*

Abstract. *The article is a review of the theoretical and methodological principles of implementation of information and communication technologies (ICT) in higher education; the technique used in the educational process of popular multimedia products in the period of this element in the educational process of distance education in difficult economic conditions.*

Keywords: *educational process, education, distance education, information resources.*

1. Introduction. Worldwide transition from an industrial to an information society requires significant education reforms, helps create conditions for realization of the right to education to everyone. Thanks to Internet technologies many aspects of our life is transferred to the network, thereby accelerating the pace of development of information society and overcome geographical barriers. No exception is education. In this process, the role of distance learning (DL) is increasing. It is now not necessarily be located next to the teacher. Use of DL might provide the educational services of different nature in remote areas to teach without taking from the main activity, educate persons with disabilities have access to educational resources of the world through the use of modern means of electronic communication.

DL is a form of teaching using modern computer and telecommunication technologies, which provide interactive interaction of teachers and students at different stages of education i work independently with informational materials networks.

DL is the sum of the following measures:

- means of providing educational material to the student;
- controls of student;
- student counseling facilities;
- interactive collaboration tools teacher and student;
- the ability to quickly add new information rate, error correction.

The development of distance learning is one of the promising areas of improvement of the education system.

The purpose of the article suggest the effective use of innovative technologies in the educational process in transition creating systems of DL....

2. Analysis of published data and problem definition

One of the main goals of the Information Society in Ukraine is to provide computer and information literacy, primarily through the creation of education focused on the use of new information and communication technologies (ICT) in the formation of a fully developed personality [1-3]. ICT - a set of methods and software and hardware combined to ensure the implementation of information processes, with

greater reliability and efficiency and reduce the complexity of information resources.

Today the attention of researchers attract different aspects of ICT in the learning process. Thus, the problems of using ICT to improve the efficiency of independent work in the educational process is devoted to research and N. Boyko A. Bayrakivskoho, indicating that the introduction of ICT in the learning process stimulates complete mastering system of knowledge and skills, developing the creative direction of cognitive activity helps formation of relevant professional and personal qualities [4]. The use of ICT in the learning process are not an end in itself, and justified the need that has significant advantages over traditional methods of independent work.

The introduction of modern information technology in everyday life society promotes innovation in education related to the introduction of forms before. Internet as a source of information and telecommunications development, without which this form of learning is impossible improved rapidly. Thus, one of the conditions of implementation problems with quality training students higher education institutions is the introduction and widespread use in teaching modern forms before.

3. The results of research

Analysis of the problems of using ICT in the classroom shows that the transition to computer-based learning technologies, creating conditions for their development, testing and implementation, rational combination of advanced teaching facilities with traditional - a problem that needs solving a complex psycho-pedagogical, organizational , teaching, logistical and other problems [5]. Among them - the development of appropriate teaching methods of use for information retrieval systems, multimedia, telecommunications and network technologies; formation of information culture of teachers and students, preparing them for the practical use of ICT in their professional activities.

The benefits of ICTs:

- Individualization and differentiation of the learning process;
- Monitoring with feedback and evaluation results;
- The implementation of self-monitoring and self-correction;
- Ensure the Exercises and homework;
- Visibility (modeling, studied and researched);
- The creation and use of databases;
- Access to online databases;
- Increased motivation to learn;
- Formation of algorithmic style of thinking;
- The development of creative abilities of the individual.

Information technology leads to the constant self-education and the learning process makes it possible to experience the practical results through the implementation itself in the global information space.

DL - a technology that is based on the principles of open learning, extensive use of computer training programs for various purposes and creates by modern telecommunications information educational environment for the delivery of educational material and communication [6].

The basis DL educational process is deliberate and controlled intensive self-

study student.

Distance learning some inherent characteristics that distinguish it from traditional forms of education:

- Flexibility - an opportunity to do on your own time, in a convenient location and pace of unregulated period of time for the development of the discipline;
- Modularity - the possibility of a set of independent courses modules to form a curriculum that meets the needs of an individual or group;
- Parallel - training on the job;
- Mass - simultaneous appeal to many sources of educational information (digital libraries, data banks, knowledge bases, etc.) of a large audience, communicating via a communication network with each other and with teachers;
- Cost - effective use of training areas, facilities, concentrated and unified view of educational information and multystep it reduces the cost of training;
- Adaptability - use in education the latest advances of information and communication technologies that promote rights in the global information space;
- Social equality - equal opportunities to obtain education regardless of residence, health status, and material well-being students;
- Internationality - export and import international achievements in the education market;
- The new role of the teacher - distance learning expands and updates the role of the teacher that should coordinate cognitive process, constantly improve its courses, increase creativity and skills in accordance with the innovations and innovation.

Distance Education in Ukraine and abroad

Nowadays, in terms of economic relations and fierce competition in the labor market are particularly important knowledge, skills and experience. Specialist XXI century - a person who is fluent in modern information technology, continuously improving and improving their skills. Asset new knowledge and skills practically useful and applicable in the information society in the era of greatly enhances self and promotes career growth. DL helps those wishing to continue their studies to overcome obstacles such as lack of time, distance.

To DL system take its rightful place in the system of education in Ukraine, it is necessary first of all to create a global computer network and education. Using modern technology and software allows institutions to provide [6]:

- Interaction between teachers and students, regardless of time and space;
- Teachers and students access to global information resources;
- Attracting highly skilled professionals from around the world;
- Cooperation with other domestic and foreign institutions, which speeds up the process of integration into the international system of education.

The purpose of the State National Program "Education" Education is output in Ukraine at the level of developed countries.

An important factor in the development of the country's informatization is to provide students with the latest information, the acquisition of the necessary skills of professional competence. Modern education requires new approaches to the introduction of innovative technologies implemented by means of software.

The essence of teachers in these conditions is the creation of methodical

discipline electronically.

For educational process management, knowledge control delivery of educational content to students and providing didactic materials necessary to develop specialized software that provides automated workflow system, electronic information database, glossary and interactive multimedia tutorials and other electronic materials for all courses. The software is installed on the server of the institution. This preparatory work requires certain material costs and can take a long time. But due to the difficult economic situation in the country at present there are problems with providing schools with the necessary equipment and software.

In order to optimize the learning process to transition the method of application of existing multimedia general use, does not require additional material costs, but can help reduce the weekly classroom workload and increase the time for independent work of students creates a qualitatively new organizational and informational resources.

4. Conclusions

Advances in telecommunications, in particular the development and widespread global computer network Internet, has identified the relevance and necessity led to the introduction of information and communication technologies in education.

The use of e-learning saves teacher time to prepare for classes, classroom time, and effectively impact on the performance of students while processing theory, practical tasks, self-control knowledge, work with auxiliary material contributes to significant results in education.

One of the important features and benefits of ICT compared with other educational tools is the fact that multimedia applications mostly designed for active self-perception and perception of the students knowledge and skills [7].

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O.V. Zakharov, A.V. Korolev, A.A. Korolev, O.A. Yalovoy
CENTERLESS MEASUREMENT OF ROUNDNESS
WITH SUBADJUSTMENT APPLICATION

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***Summary.** This is a scientific research, which advances arguments in favor of the measurement and data processing method of centerless measurement of roundness with subadjustment application. It presents a mathematical model using iterative method and harmonics analysis which in addition considers change of contact points' locations of a prism sides with a detail at rotation. The research results based on real measurements and modeling make it possible to avoid or minimize the systematic errors and increase the centerless measurement accuracy of roundness.*

Introduction. A surface form shape – how to make it more efficient? Control of machines and mechanisms details' surface form is an actual task that constantly draws attention of experts. Accuracy of a rotation body shape in cross section is standardized by a roundness indicator which shows, how real profile differs from a basic circle. The minimum zone tolerance circle is recommended in the ISO 12181-1:2011 standard as the main option of coordinate basic origin, but the use of the extracted derived features in the form of adjacent (external and internal) circles (Maximum Inscribed Circle, Minimum Circumscribed Circle) or the Least Squares Circle (LSC) received by the method of the Ordinary Least Squares (OLS) is allowed. The choice of one of the specified basic circles has to be defined by a functional purpose of a machine or mechanism's detail.

Various requirements to accuracy, productivity and conditions of control have brought us to creation of a set of methods and gages, each of which can't be universal [1]. Methods of radial, coordinate and differential measurement of roundness are known. Each of the specified methods has certain specific features and assumes use of various measuring devices and algorithms of results' data processing.

At a difference method instead of absolute values of the quantity the difference between its consecutive values are measured divided by a certain interval. Though the analytical dependence between measured and sought quantities is unknown. For roundness measurement in shop conditions with two-point contact devices are generally applied (micrometers and Snap Gages) and three-point contact (various combinations of prisms and sensors of fine linear displacements). The considered centerless method in this work belongs to the last kind of measurement.

The essence of the centerless measurement method consists in the following that the detail rotates and leans on sides of the prism directly by its measured surface, and the sensor of fine linear displacements registers the roundness. The main lack of this scheme is the systematic measurement error reaching by various estimates up to 100% [2, 3]. And despite its obvious advantages – simplicity of the device and high efficiency, that abovementioned disadvantage limits the range of this effective method's application.

Mathematical model development and validation of centerless roundness measurement

The known mathematical model of centerless measurement described in the work [1], assumes a detail's contact points invariance with prism sides during the process monitoring. The given dependences are fair only for separate harmonics as they do not consider harmonics' initial phases, which don't allow using the principle of superposition correctly. The results received due to the use of this model are more of private character, which creates certain difficulties in their use in practice.

But the new developed model of centerless measurement of roundness is more adequate to the real process. It's focused on use of numerical methods and harmonics analysis. The mathematical description of the measurement process should be considered in three steps: finding a profile's average circle center of after it's positioned (for each current provision of a detail); determination of radiuses of the profile points measured by the sensor; resultant calculation of roundness by the measured points.

The work [4] presents the cross profile of a detail, which is described by a trigonometric polynomial in the best way. Values of amplitudes and initial phases of harmonics are received on the basis of the harmonics analysis of actual details' profiles. Therefore it becomes possible to simulate both an exact detail profile, and profiles of a certain kit of parts. In polar system of coordinates the profile is set as follows:

$$r = R + \sum_{n=2}^p a_n \cos(n\varphi - \varphi_n) . \tag{1}$$

Where R is the radius of an average circle; a_n, φ_n – the amplitude and initial phase of harmonics n ; p – the largest eigenvalue of harmonic; φ – polar angle.

The positioning inaccuracy is defined at the first stage, which is a deviation of actually reached part location from the location of nominally cylindrical part of R radius without form deviations. In this case in the demanded position of part's center (point 0) in its cross section is unambiguously defined by the R radius and prism angle α (Fig. 1).

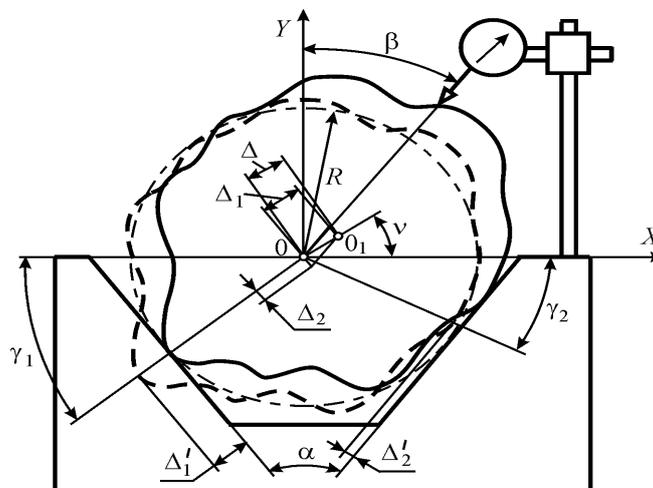


Fig. 1. Design diagram of measurement

The straight-line boundary equation of a prism in the polar system of coordinates:

$$r_1 = R / \cos(\lambda - \varphi), \quad (2)$$

Where λ – is the angle setting the perpendicular to the verge (for the left face $\lambda_1 = 180^\circ + \alpha/2$; for the right verge $\lambda_2 = 360^\circ - \alpha/2$).

Contact points of a detail with prism verges will be the profile points which are most close located to prism verges. Using the numerical method let's find a gap Δ' and a polar angle γ between a verge and a detail in an initial position:

$$\Delta' = \{r - r_1\} \rightarrow \max. \quad (3)$$

By results of finding of a maximum of functionality (3) angles γ_1, γ_2 and gauges Δ'_1, Δ'_2 for each prism verge are defined at the current angle of part's rotation.

We consider that the detail constantly and simultaneously is in point contact with both verges of a prism. Therefore at a form deviation in contact points the detail is theoretically displaced in the directions of angles of γ_1 and γ_2 , and the actual shift happens along prism verges. Thus, the detail consistently moves on prism verges at values Δ_1 и Δ_2 which are projections of Δ'_1 и Δ'_2 :

$$\begin{cases} \Delta_1 = \Delta'_1 [\sin(\gamma_1 + \alpha/2) + \cos(\gamma_1 + \alpha/2) \operatorname{ctg} \alpha]; \\ \Delta_2 = \Delta'_2 [\sin(\gamma_1 + \alpha/2) + \cos(\gamma_1 + \alpha/2) \operatorname{ctg} \alpha]. \end{cases} \quad (4)$$

Position of a part center O_1 after it's positioned is calculated by vector addition of shifts:

$$\left. \begin{aligned} \Delta &= \sqrt{\Delta_1^2 + \Delta_2^2 - 2\Delta_1\Delta_2 \cos \alpha}; \\ v &= \arctg \left[\frac{(\Delta_1 + \Delta_2) \operatorname{tg} \alpha}{2(\Delta_1 - \Delta_2)} \right]. \end{aligned} \right\} \quad (5)$$

At the second stage we determine radiuses r_2 of the measured detail's profile points after the detail is positioned. The initial data are the profile's average circle center coordinates (Δ, v) received at the first stage and profile points' radiuses r_i of the detail.

In the beginning it is necessary to convert a detail profile coordinates into the Cartesian coordinate system taking into account center shift:

$$\begin{cases} x_i = r_i \cos \varphi + \Delta \cos v; \\ y_i = r_i \sin \varphi + \Delta \sin v. \end{cases} \quad (6)$$

For determination of dependence between the radius-vectors r_2 and r it is expedient to use the numerical method. As the measuring sensor can move only along the straight line which has been set by the angle β , it registers the point most close located to this straight line. Therefore the task is reduced to the search of the profile point having the shortest distance d to the straight line of the sensor's movement:

$$d = |y_i - x_i \operatorname{tg} \beta| / \sqrt{1 + \operatorname{tg}^2 \beta} \rightarrow \min. \quad (7)$$

Where x_i, y_i – Cartesian coordinates i of the detail's profile point.

According to the results of minimization of functional (7) there is radius r_2 for each current angular location of a detail.

As a result of calculations with formulas (1) – (7) the measured profile in the Cartesian system of coordinates is received. Converting coordinates from Cartesian to polar system, we build out-of-roundness profile.

In the third phase, determine the roundness X value, which is the maximum distance from the profile points to the base circle. The simplest method of calculation of deviation from roundness is the Least Squares Circle. If the center of the average circumference of the out-of-roundness profile coincides with the beginning of the coordinate system, then the roundness X is the difference between maximum and minimum of the radiuses. If not you need further to define the coordinates of the LSC center and then the roundness value. For finding the roundness X from the Minimum Zone tolerance circle, you can use the methods outlined in the work [2].

Measurement and modeling strategy of the centerless measurement of roundness

The proposed strategy of the centerless measurement of roundness is based on the subadjustment and assumes repeated measurements of the same detail. The first dimension allows identifying the harmonics' structure of the profile in the first approximation. These data are used for modeling according to the developed program the result of which will be new parameters of adjustment of the device. After a repeated measurement the accepted adjustment compares the obtained values of harmonics' structure and roundness with the initial values. If the roundness value is reduced by less than 10%, the setup settings are optimal. It is assumed that the value of 10% is a systematic error of measurement. Otherwise, the process of modeling and subadjustment is repeated. As a rule, in practice the subadjustment process is limited to two or three measurements. The complexity of such measurements increases but simulation on designed programs is much faster than actual measurement on the device. Therefore, the centerless dimension performance won't concede to coordinate or radial methods.

The numerical experiments have shown that when using a prism with a constant angle and angular position of the sensor it is impossible to provide not only a small error of measurement for all harmonics, but roughly constant for the first 20 harmonics. This result is consistent with similar data given in work [1]. Systematic error is from about 5% to 9 harmonics up to 105% for the 8 harmonics. The results obtained can be used when configuring the appliance only when there is one dominant harmonic in a detail's profile which is rare in manufacturing technology. The principle of superposition in modeling centerless measurement isn't observed because of the nonlinearity of system. Therefore, the recommendations for individual harmonics do not enable you to efficiently minimize measurement error in actual production conditions.

With the purpose of research of the systematic errors and the ways of its bias to minimize the conducted measurement and modeling for 50 external bearings' rings with a diameter of 30 mm tolerances of 0.002 mm roundness. Reference measurements were compared with the measured and simulated details' profiles. The work was done on a precision roundness measuring machine Talyrond 30. At centerless measurement a prism angle $\alpha = 60, 90, 120^\circ$ and sensor angle $\beta = 0, 15, 30, 45, 60, 75^\circ$ were varied. Linear displacement sensors of Mitutoyo Company with of 0.1 μm resolution was applied. The results are presented in Fig. 2 for the relative error average value and in Fig. 3 – for the standard deviation of the measurement error.

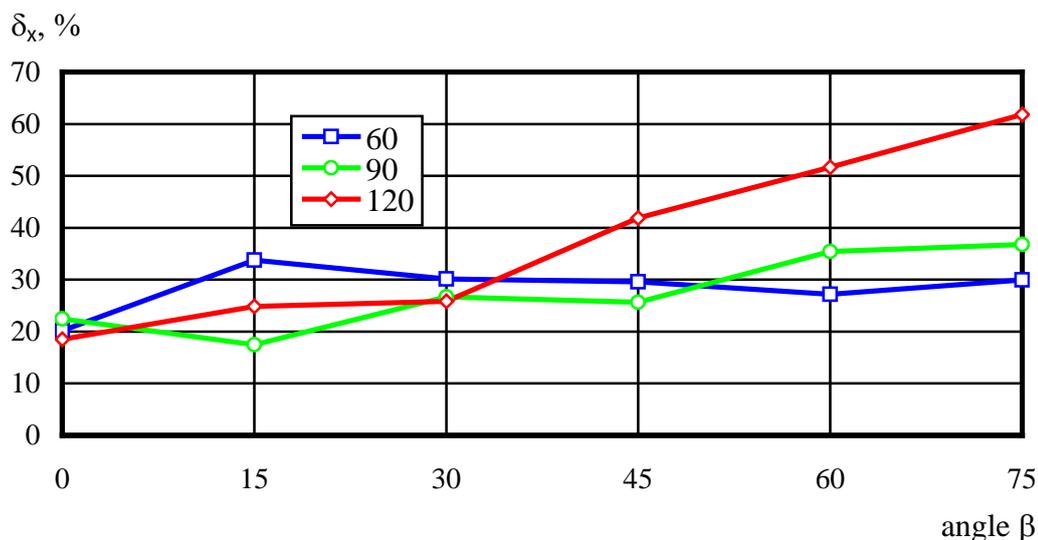


Fig. 2. The relative measurement error, the average value: blue diagram – prism angle 60 degree; green diagram – prism angle 90 degree; red diagram – prism angle 120 degree

On the charts we can draw a conclusion that the prism angle and sensor angle affect the measurement accuracy. For individual details and device settings the relative error of measurement reaches 120%. For a kit of parts the maximum value of the relative error is $\delta_x = 62\%$ and corresponds to the parameters $\alpha = 120^\circ$, $\beta = 75^\circ$, minimum is equal to $\delta_x = 17.5\%$ for the parameters $\alpha = 90^\circ$, $\beta = 15^\circ$. The standard deviation for the specified options amounted to $\delta_x = 26\%$ and 14.5% respectively. Thus the optimal adjustment for a kit of parts allows reducing at the same time average value of a systematic error and its standard deviation. The minimum value of the standard deviation does not always correspond to the minimum average value of error. This is important for optimal device setup for an exact kit of parts.

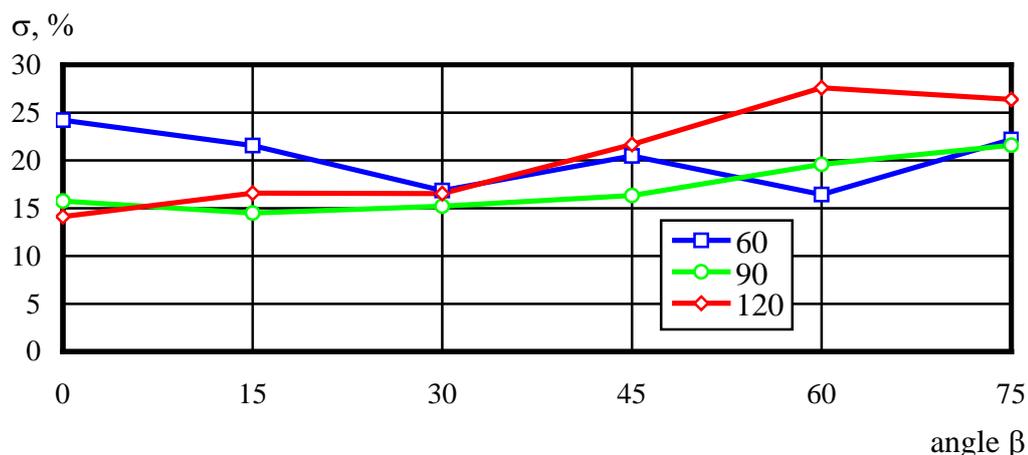


Fig. 3. The relative error of measurement, standard deviation: blue diagram – prism angle 60 degree; green diagram – prism angle 90 degree; red diagram – prism angle 120 degree

Resume. The conducted researches allow drawing a conclusion that centerless

measurement of roundness on a prism with a linear motion sensor has a systematic error of the analytical information which is difficult depending on harmonic structure of deviations of details' form. The superposition principle for combination of harmonics is not observed because of the nonlinearity of the system. Setting up of the unit without knowledge of harmonic structure of errors of a form is ineffective under real production conditions.

The relative accuracy of measurements in experiments runs up to 120%. However, systematic errors can be reduced by selecting values of the device settings – prism angle and sensor position. The optimal configuration of the device reduces measurement errors up to 15-20%. The configuration of the device should be performed on the basis of the offered algorithm in several stages. Optimal settings can be found for each detail, and for a certain kit of parts.

The Conclusion. Sound method of centerless roundness measurement based on the subadjustment using new mathematical model allows minimizing systematic error effectively. In this case the centerless measurement becomes good alternative measurement methods of precision roundness measuring machine or coordinate and measuring machines, more accessible for users.

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J11510-020**Gasanov E.V., Gasanova S.E.****THE USE OF FREE SOFTWARE IN TEACHING WEB-PROGRAMMING***National Research University «Higher School of Economics»,
Moscow, Myasnitskaya 20, 101000*

Abstract. In the National Research University «Higher School of Economics» developed a method of learning web programming, which uses free software: the PHP programming language and MySQL database.

Keywords: free software, web-programming, PHP, MySQL.

When choosing between Free Software and proprietary software used in web programming, it was decided to use Free Software. Free Software provides a unique opportunity to study the documented source code of Free Software. Free Software, as the software is open source, can be used as a source of knowledge about building algorithms. This allows students to acquire more knowledge and skills in the field of information technology.

Important is the use of Free Software is independence from foreign manufacturers and software vendors.

So for learning web programming we use programming languages JavaScript, PHP and MySQL database.

Learning web programming is carried out in the framework of the course «Creating Internet projects». The course «Creating a web project» consists of 5 courses:

1. «Creating Internet projects. Level 1. HTML»;
2. «Creating Internet projects. Level 2. Language CSS»;
3. «Creating Internet projects. Level 3. The basics of the programming language JavaScript»;
4. «Creating Internet projects. Level 4. The basics of the PHP programming language»;
5. «Creating Internet projects. Level 5. Developing Web applications using PHP and MySQL».

These disciplines are implemented as university electives in the National Research University «Higher School of Economics» (HSE) (http://www.hse.ru/org/hse/elective_courses/webdesign/web1).

Client-side web programming is studied in the discipline of «Creating Internet projects. Level 3. The basics of the programming language JavaScript». Server-side web programming is studied in the disciplines «Creating Internet projects. Level 4. The basics of the PHP programming language» and «Creating Internet projects. Level 5. Developing Web applications using PHP and MySQL».

The purpose of learning the discipline «Creating Internet projects. Level 3. The basics of the programming language JavaScript» are:

- getting students theoretical knowledge of programming language JavaScript;
- practical skills scripting using JavaScript.

The purpose of learning the discipline «Creating Internet projects. Level 4. The

basics of the PHP programming language» are:

- getting students theoretical knowledge about the use of the PHP programming language;
- practical skills development server-side scripting using PHP.

The purpose of learning the discipline «Creating Internet projects. Level 5. Developing Web applications using PHP and MySQL» are:

- getting students theoretical knowledge on the use of query language SQL;
- practical skills for developing web applications using PHP and a MySQL database.

In preparing this course was developed to study web programming using Internet. What problems were solved during the development of the methodology?

First, because the course is designed for students who have no training in programming, it was necessary to make the course content is sufficient to create simple web applications (scripts), as well as understanding and modification of the source code ready scripts. Judging on the mentioned objectives proposed the following disciplines related to web programming:

The content of the discipline «Creating Internet projects. Level 3. The basics of the programming language JavaScript»:

1. Introduction to JavaScript. Variables and data types;
2. The operators of the JavaScript language;
3. The input and output of information;
4. Conditional statements;
5. Organization cycles;
6. Functions;
7. Built-in JavaScript objects. Arrays;
8. Objects String, Date, Math;
9. Events and event handling;
10. Object model browser.

The content of the discipline «Creating Internet projects. Level 4. The basics of the PHP programming language»:

1. Introduction to PHP. Variables and data types;
2. Operators of PHP;
3. Conditional statements;
4. Organization cycles;
5. Functions;
6. Functions for working with strings;
7. Functions for working with arrays;
8. HTML forms and PHP.

The content of the discipline «Creating Internet projects. Level 5. Developing Web applications using PHP and MySQL»:

1. The MySQL database. Language SQL;
2. Access to a MySQL database from the Web with PHP;
3. Retrieving data;
4. Updating data;
5. Adding data, deleting data;

6. SQL statements to create complex queries;
7. Changing the database structure;
8. SQL functions.

Secondly, were developed training materials «Practical course of creating Internet projects. The basics of the programming language JavaScript» [1] and «Practical course of creating Internet projects. The basics of the PHP programming language» [2].

Thirdly, exercises, practical exercises designed so that students independently perform these exercises and independently verify the correctness of their implementation. This is achieved developed by way of practical exercises: for each task, the listener is offered a sample script that you want to enter using the program «Notepad++», and the appearance of the web page, which corresponds to the result of the script execution.

Fourth, to test the actual level of skills and abilities that are difficult to determine using tests developed method that allows you to realistically assess the achievements of the learner. Developed evaluation method is implemented using a special task, in which listeners are encouraged to develop a web application that performs the specified actions.

Course materials for practical classes: lecture notes, exercises, tests, posted on the web site <http://www.computerschool.ru>. Access to learning materials on the web site is password which is sent to the teacher via e-mail.

Each discipline consists of 5 lessons. Each session includes a lecture and practical session. Each practical session, students independently perform exercises for each topic, which consists of several tasks. After successful execution of the tasks of the exercise, the student completes a quiz about the topic.

Performed audit work are posted on the personal website of the student. Students of the course record personal web site on any free hosting that provides the opportunity to work with PHP scripts and MySQL database or paid hosting. On the basis of the analysis of hosting service it was decided to recommend to listeners hosting company Hostinger Group (<http://www.hostinger.ru>). This hosting supports PHP and MySQL, and doesn't publish on websites advertising.

Thanks to the developed technique at the end of the studies related to web programming students:

- learn the basics of programming languages, JavaScript and PHP;
- learn how to create simple scripts using programming languages, JavaScript and PHP;
- acquire skills development scripts using the intrinsic JavaScript objects and scripts to process forms;
- will have experience developing PHP scripts to process forms;
- learn the basics of structured query language SQL;
- learn the basics of working with a MySQL database;
- will learn to develop web applications using PHP and MySQL.

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J11510-021**Melnikov A.Y., Kijashko Y.Y.****PROCESS MODELING OF OFFICE EQUIPMENT MAINTENANCE BY SYSTEM AND TECHNICAL SUPPORT DEPARTMENT***Donbass State Engineering Academy,
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Abstract. Processing of office equipment maintenance applications by system and technical support department has been considered. The approach how to choose the right specialist to process applications has been offered. The mathematical model of decision making support for employee appointment to perform the required tasks on the basis of agent-oriented approach has been worked out. The algorithm that implements the mathematical model has been developed.

Keywords: office equipment maintenance, application, mathematical model, agent-oriented approach, algorithm.

Nowadays almost all kinds of organizations use computing hardware which requires a periodic maintenance and troubleshooting. As a rule such problems are solved by a special service that has specialized software which is capable to eliminate errors and defects [1].

The main idea of office equipment maintenance process by a special service is to accept the application, to analyse the department structure and to test the equipment where a defect has been found out, make a list of defect corrections and, if the problems haven't been solved, then to send an application for the specialist to work over them. One of the main problems at this stage is the problem of manpower resources distribution, which includes selection, personnel placement and appointment of a specialist to perform a required work.

The multi-agent computer systems (MACS) are used to solve the problems of labor resources. Within all the varieties of MACS implementations some mathematical models and agent interaction algorithms still need to be developed. That will allow to reveal and analyze their ability for adaptation and self-organization [2].

As a result of systems analysis for the applications' processing it has been found out that the main disadvantages of software used are its inconvenience and implementation problems with much time consuming and financial costs. Most of software products aren't provided with automated choice of a specialist to process applications.

To improve labor resources efficiency as for application processing in the sphere of office equipment maintenance on the basis of effective labor resources methods and taking into account the specificity of the work and an employee's psychological characteristics it is considered to be an important problem.

The aim of the research is to work out process modeling of office equipment maintenance by system and technical support department.

The way of how to choose the right specialist is based on agent-oriented approach [3]. Each task (application) and each employee is represented with individual agents. Their objective functions are defined to provide the interaction of

agents.

The objective function of a task category (1) is to maximize specialist's operating efficiency:

$$f_{T_i} = \max \sum_{i=1}^n \sum_{j=1}^m \varepsilon_{W_j T_i} X_{ij}, \tag{1}$$

The objective function of an employee category (2) is determined by minimization of a load factor:

$$f_{W_j} = \min \sum_{i=1}^n \sum_{j=1}^m k_{load_{W_j}} X_{ij}, \tag{2}$$

where $X_{ij} = \begin{cases} 1, & \text{if } j \text{ employee performs } i \text{ task;} \\ 0, & \text{in other cases.} \end{cases}$

The load factor is defined with the formula (3):

$$k_{load} = \frac{V_{ToBePerformed} - \sum_{j=1}^n Prior_{T_j} V_{assigned_{W_j}}}{V_{6bitn}} \tag{3}$$

where $V_{ToBePerformed}$ – the number of applications to be performed by an employee; n – the number of employees; $V_{assigned_{W_j}}$ – the number of applications the department accepts and which are assigned to employees; $Prior_{T_j}$ – task priority.

The operating efficiency is defined with the formula (4):

$$\varepsilon_{W_j} = k_{efficiency} \frac{V_{T_i}}{t_{T_i W_j}}, \tag{4}$$

where V_{T_i} – the whole amount of employee's work, $t_{T_i W_j}$ – the average duration of employee's operation done, $k_{efficiency}$ – efficiency factor

The efficiency factor is a complex coefficient and is calculated with the formula (5):

$$k_{efficiency} = S_{W_j} + k_{knowledge} + k_{respons} + k_{reliab} + k_{perform}, \tag{5}$$

where $S_{W_j}(t) = \frac{V_{W_j}}{V_T}$ – coefficient of employee's speed performance, V_T – the total amount of applications done in the department, V_{W_j} – the amount of applications performed by an employee W_j ;

$$k_{knowledge} = \frac{X_1 Z_1 Tech_1 + X_2 Z_2 Tech_2 + \dots + X_n Z_n Tech_n}{k_1 Tech_1 + k_2 Tech_2 + \dots + k_n Tech_n} - \text{knowledge factor,}$$

Z_n – coefficient that indicates employee's technique skills, $Z_n = [0,1]$, $k_n Tech_n$ – the amount of the work to be carried out with the help of special techniques $Tech_n$, n – the number of techniques (methods);

$$k_{reliab} = \frac{N_{w.d.} - N_{r.d.}}{N_{w.d.}} - \text{reliability index, } N_{w.d.} - \text{the number of work days,}$$

$N_{r.d.}$ –the number of employee’s W_j missing days at work;

$$k_{perform} = \frac{R_{total} R_{fulfilled_{w_j}}}{R_{total} R_{fulfilled_{w_j}} + R_{total} R_{unfulfilled_{w_j}}} - \text{job performance factor} - \text{the}$$

proportion of the applications processed in corpore to the applications accepted by an employee , R_{total} – total amount of applications accepted by the department, $R_{fulfilled_{w_j}}$ – the number of fulfilled employee’s applications, $R_{unfulfilled_{w_j}}$ – the number of unfulfilled employee’s applications;

$$k_{respons} = \frac{R_{unfulfilled_{w_j}}}{R_{total}} - \text{responsibility factor.}$$

The general solution (6) is functional combinations of a task category (1) and an employee category (2):

$$F = \max \sum_{i=1}^n \sum_{j=1}^m \varepsilon_{W_{ji}} \cdot (1 - k_{load}) \cdot X_{ij}. \tag{6}$$

To implement the mathematical model it is necessary to work out an algorithm that will allow to appoint a specialist to process applications (Fig. 1):

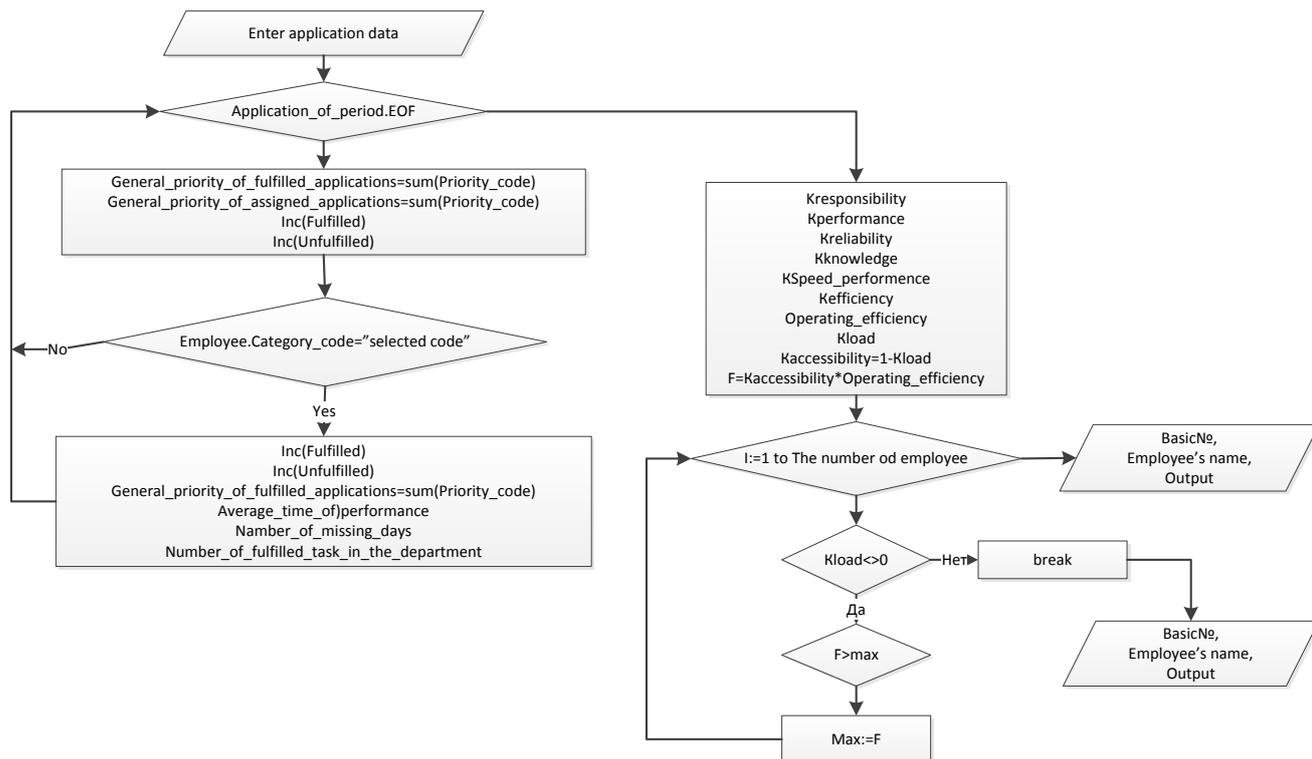


Fig.1. Flowchart of the algorithm

Conclusions. The paper presents a mathematical model of decision-making support in choosing of an employee to perform required tasks, taking into account his psychological characteristics. This mathematical model shows the distribution of human resources based on agent-oriented approach that helps to solve the problem of employee’s appointment. The algorithm for the implementation of the mathematical model has been worked out. Simulation modeling of input parameters to predict employees’ load has been chosen as one of the ways to improve this mathematical

model in the future.

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J11510-022

Melnikov A.Y., Larchenko A.V.

THE MODELING OF BUDGET ALLOCATION OF THE DEPARTMENT AT THE ENGINEERING ENTERPRISE

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Abstract. The department budget allocation at the engineering enterprise has been considered. The information model of a system to optimize the department's budget has been provided. Software support of Embarcadero Delphi XE4 has been described.

Keywords: enterprise budget, the budgeting process, dynamic programming, game theory, decision making, the Unified Modeling Language, visual programming.

Introduction. In Ukraine domestic enterprises have shown recently an increased interest to the system of budgetary control. It has been caused by objective reasons - the growth of production, increasing competition.

The value of a well-organized system of corporate planning increases in the competition in terms of enterprise stability. This system covers all the departments and uses modern methods of management organization and information technologies. This is the system that is applied in budget planning and management (budgeting) [1-2]. The problems of budget planning were studied by foreign scientists such as A. Upchurch, C. Drury, C. Horngren, J. Foster etc., and by Russian analysts such as V.M. Anshin, V.I. Danilin, S.G. Falco, V.E. Khrutsky etc.

The purpose of this article is to develop an information system formalizing the problem of dynamic programming. It is appropriate to use the decision problem here.

The decision problem for the budget allocation of the enterprise department is advisable to decide on the basis of dynamic programming [4-5]. Here is the idea of the problem: the management of the department has to develop its budget allocation strategy (budget specific costs per a tonne of manufactured items), of a desired value C in N of expense items that will minimize the risks in delayed implementation of the production program.

The variables of the problem are the volume of investments x_j in j of expense item, the expected risk caused by financing deficit is described with a given function $r_j(x_j)$, $j = 1, \dots, N$; restrictions are $x_1, \dots, x_N \geq 0$, $x_1 + \dots + x_N \leq C$, and total risk can be taken as as the objective function - $r_1(x_1) + \dots + r_N(x_N)$. If we mark $R(x)$ as a function of the total risk in delayed implementation of the production program, we can formulate the problem of finding the optimal budget allocation strategy in the form of (1):

$$\begin{aligned} R(x) &= \sum r_j(x_j) \rightarrow \min. \\ (x_1, \dots, x_N) &\geq 0, \\ \sum_{j=1}^N x_j &\leq C. \end{aligned} \tag{1}$$

The results of the solution must obey the conditions (2):

$$\sum_{j=1}^N x_j \leq C, f_N(C) = \sum_{j=1}^N r_j(x_j^*).$$
(2)

Let's consider a typical enterprise, where classical budgeting system with a "bottom-up" scheme is applied. To determine the fund amount for the budget allocation of the department, the strategy of budget specific costs per a tonne of manufactured items is used, in accordance with a fixed standard in UAH exclusive of VAT.

In order to make the budget calculation computer-aided (automated) it would be appropriate to develop an information system that will help a manager adopt the budget, allocate specific costs in optimal way, taking into account various factors that can effect the volume of the allocated amount of cash.

The system engineering was carried out on the Unified Modeling Language UML [3]. The functionality of the system is represented in the use case diagram (Figure 1), the structure is shown in the class diagram (Figure 2).

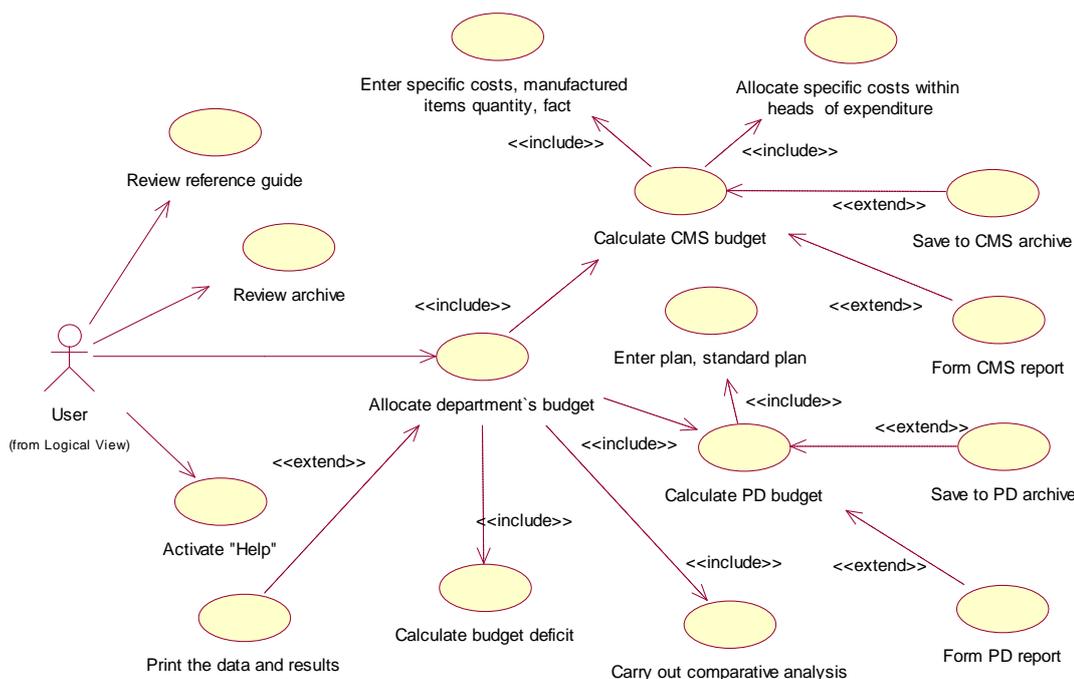


Fig.1. Use Case diagram

The optimal software for model making is Embarcadero Delphi XE4, as the ease of its interface, the simplicity of desired controls should become important characteristics of the program. The software product includes seven forms that allow to implement and evaluate the budget allocation (fig.3- 4).

Conclusions. While applying the system, the user can perform the budget allocation in two ways, to get a visual graphic information about allocated cash resources and budget deficit within heads of expenditure.

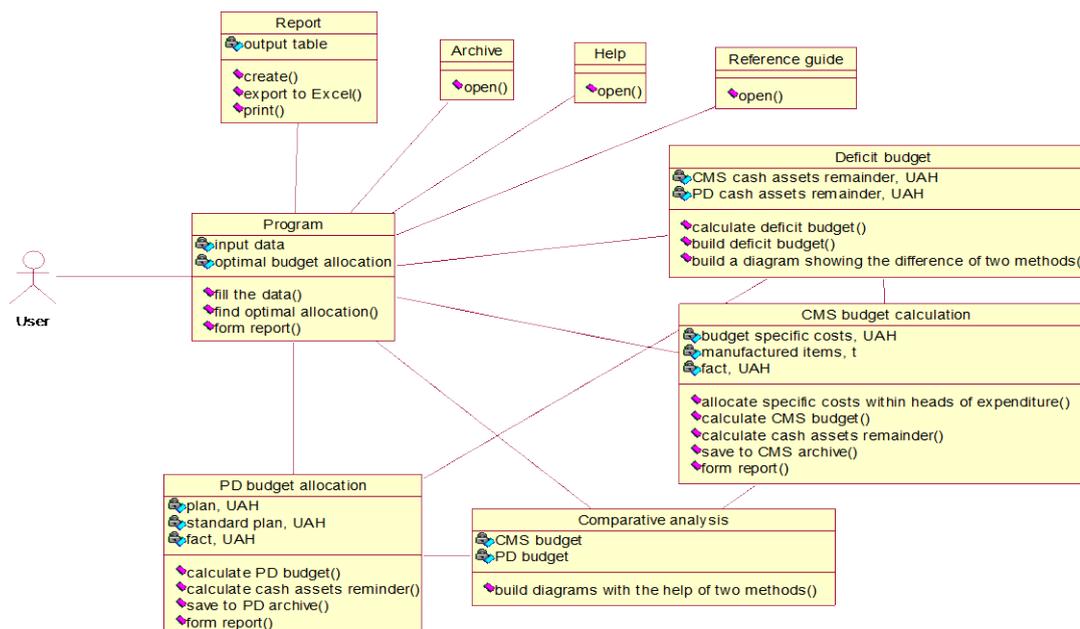


Fig.2. Class diagram



Fig.3. Budget calculation on the basis of specific costs strategy

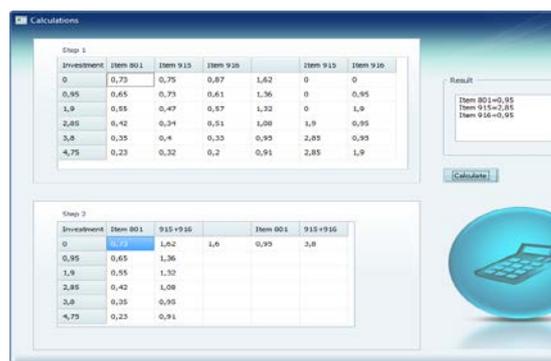


Fig.4. Budget specific costs allocation in items

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J11510-023**Shchelokov S.A.****IMPLEMENTATION OF SEMANTIC MODEL OF DATABASE
PROGRAMMED QUALITY ASSESSMENT SYSTEM***Orenburg state university*

In this work the method of modeling, design and implementation of communication applications with object files of the information presented in the form of frames and slots at the vertices of a semantic network.

Keywords: conceptual modeling of automated information systems, semantic networks, frames, slots, information- logical database model.

This method for the design and creation of an automated information system (AIS) is not based on the traditional theory and practice of relational databases [1] and on the theory of conceptual modeling systems of organizational management [2,3]. Modern methods of design and create databases based on the traditional theory of relational databases are limited to current levels of volume and shape of the processed information from the need to describe the constraints of the database. In addition, the use of object-oriented design AIS problems object representation of the database. In a relational database (RDB) is not permitted storage and processing of data arrays, as they violate the requirements of the normalization of the first normal form.

In addition, the author of this article argues that it is impossible to build an ideal object-oriented database, because this is equivalent to putting the information into a cell black box. Modern technologies allow to translate database attributes in static properties and say that this database is the class. However, in the dynamics when handling information requests logic unpredictable and describe the conditions imposed on the integrity constraints database impossible. Therefore really discuss issues related to the organization of interaction of the object class program with arrays of information domain.

Object-oriented software fully implements the method chosen analytical processing of information, and one-dimensional arrays, organized in hypercubes, do not require compliance with the requirements of normalization of relational databases. The proposed method is based on the article in the process of describing a semantic network, the vertices of which are frames and slots. Later modeled the interaction of objects with AIS is not RDB, and arrays of data in the hypercube, interpreted on the basis of the frame - shaped slot. The concept of a primary key (PK) in relationship database is not used. To communicate with the application object arrays of information instead of the PC used pointers in slots and links to frames.

One element of novelty of the method consists in the new representation of information and logical models and data-logical database. In the theory of relational database information and logic model is presented in the form of ER-diagrams (diagrams entity - relationship) or in the form of a semantic object model. In the proposed method of information-logical model is represented as a semantic data model [4]. Consider the implementation of this model for a specific example. Developing AIS qualimetric assess of the quality of products and services. Semantic

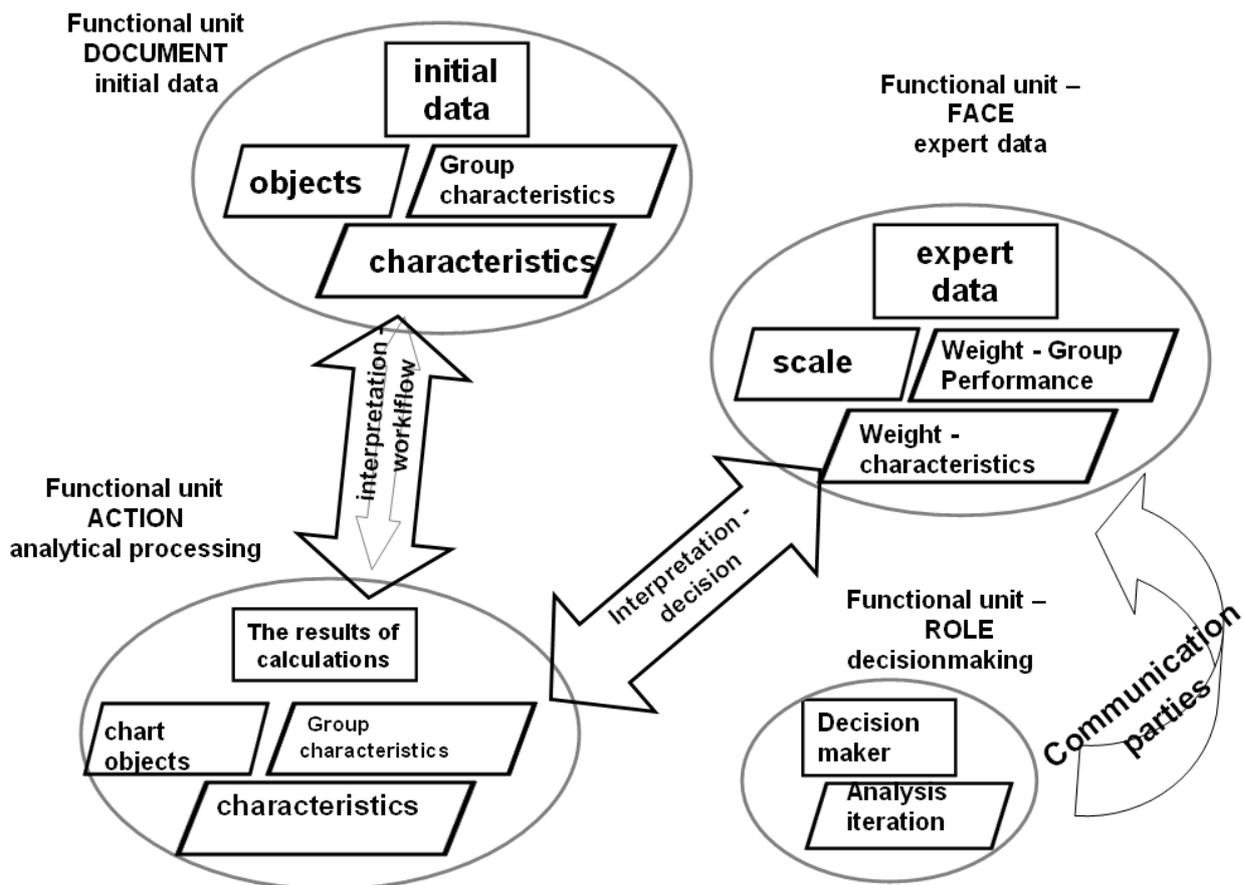
database model of the AIS has the form shown in Figure 1.

In the future, it is necessary to make the interpretation of data arrays in hypercubes (Fig. 2) to organize the presentation logic (interfacing software tool AIS), for the organization of the business logic (analytical processing) and data storage logic arrays of information on the physical level.

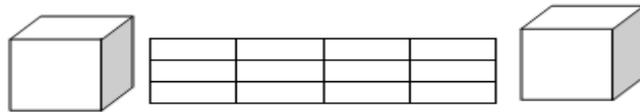
Semantic data modeling information in objects is a logical transformation of two-dimensional arrays of information in hypercubes (Fig. 3).

For qualimetric software system, the method of analytical processing on the basis of the weighted average of the geometric figure (SVGP) quality. On the basis of the method chosen to develop a class object program. On the following figures show the fragments of interpretation amounts of information in hypercubes. To store the names of projects and assess the quality of implemented array NameProject. Each project has a certain set of global variables (B, K, L), which must be stored in an array BProject, LProject, KProject. Index of the last array refer to the bulk NameProject (Fig.4.).

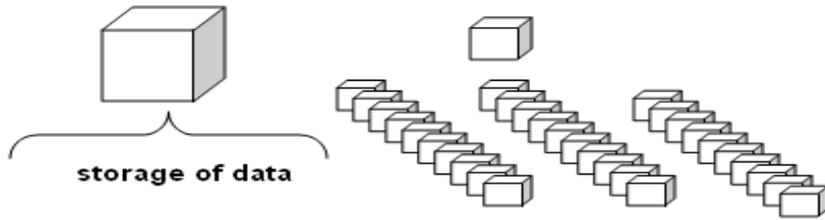
Fig. 1. The semantic database model
The semantic database model



subclass (object) of presentation logic in a show-window of data



subclass (object) of business logic



subclass (object) of basic data

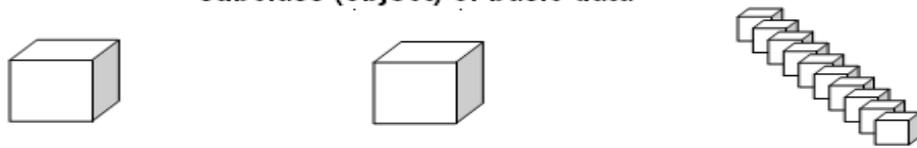
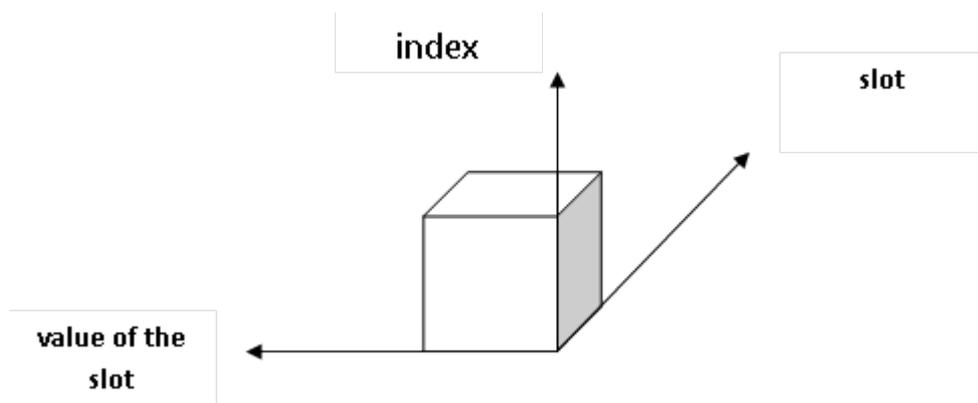
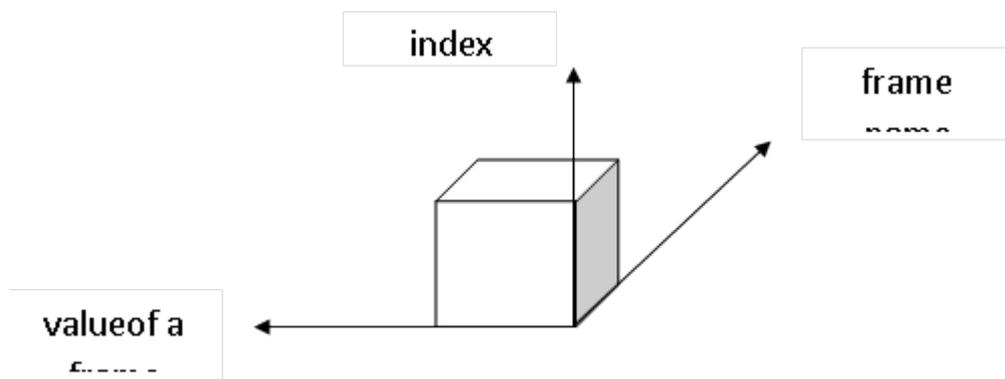


Fig.2.

Array M: {2; ± ∞}

index	name									
	value									



NameProject			
Index			
Value (project name)			

BProject			
Index			
Value (variable B)			

LProject			
Index			
Value (variable L)			

KProject			
Index			
Value (variable K)			

Fig.4. Arrays to store variables of the project quality assessment

The implementation of this structure in traditional RDB tables presented in Figure5.

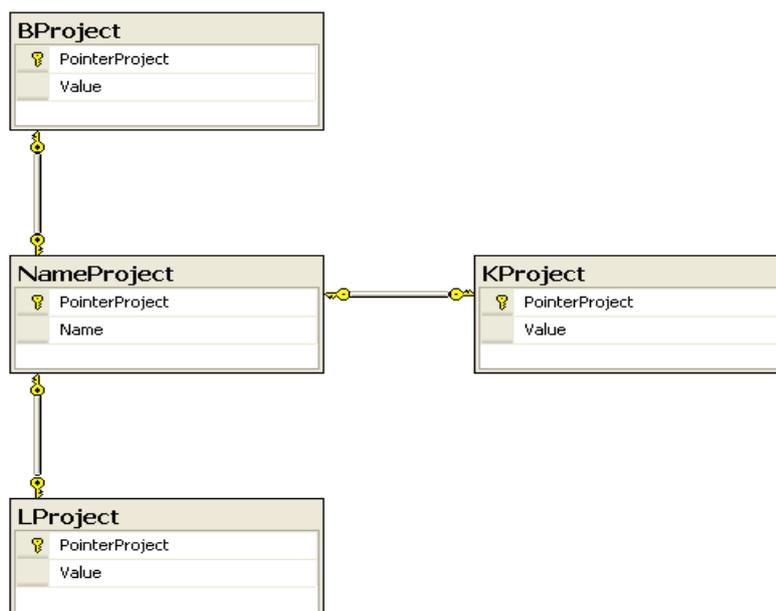


Fig.5. Communication scheme tables with design variables

To store the measurement characteristics of the samples produced in the project evaluation is necessary to organize a multi-dimensional data structure (Figure 6).

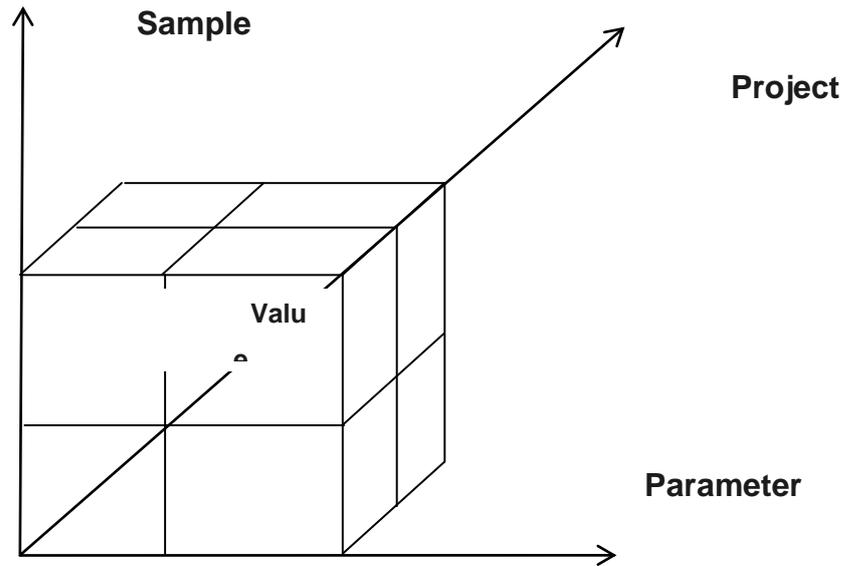


Fig. 6. Hypercube "Measurements of performance"

The measurements are based on the hypercube array index NameProject, NameParam and NameModel:

NameProject

Index			
Value (project name)			

NameParam

Index			
Value (name of characteristics)			

NameModel

Index			
Value (name of model)			

Fragments of the implementation of hypercubes and their planes are shown in Figures 7 - 11.

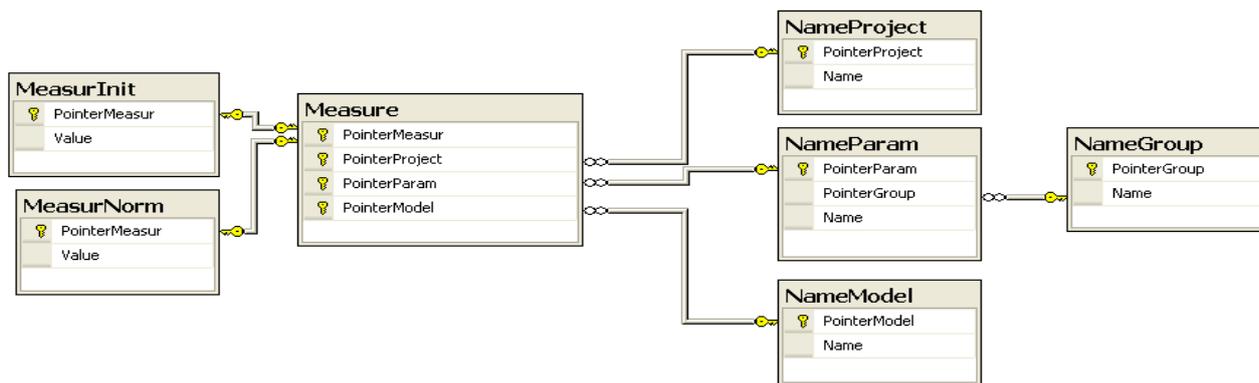


Fig. 7. Implementation of the hypercube "Measurements of characteristics"

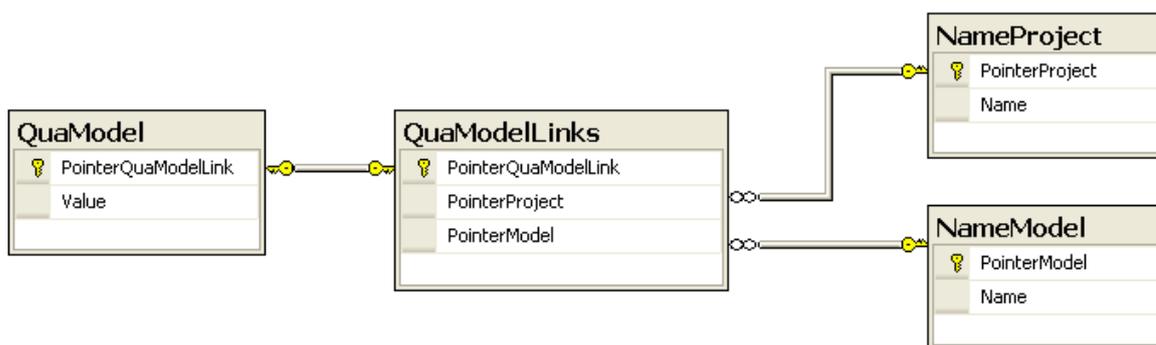


Fig. 8. Implementation of the plane "Specimen"

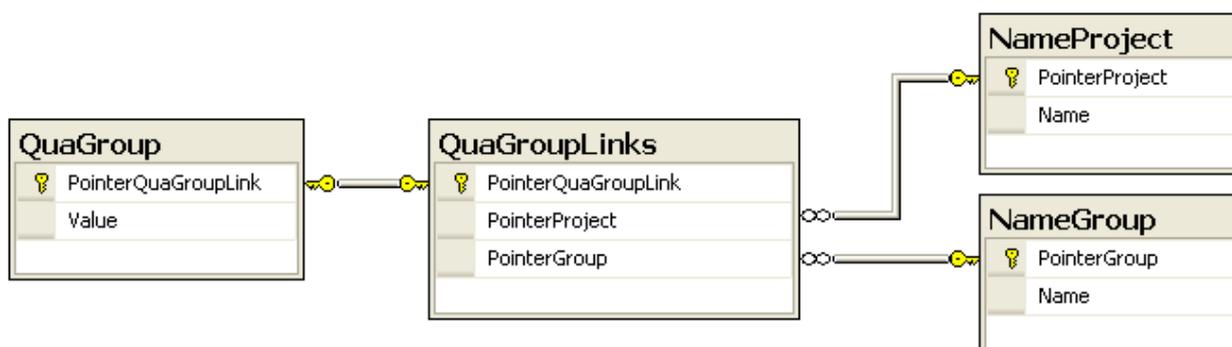


Fig. 9. Implementation of the plane "quality characteristics of the group"

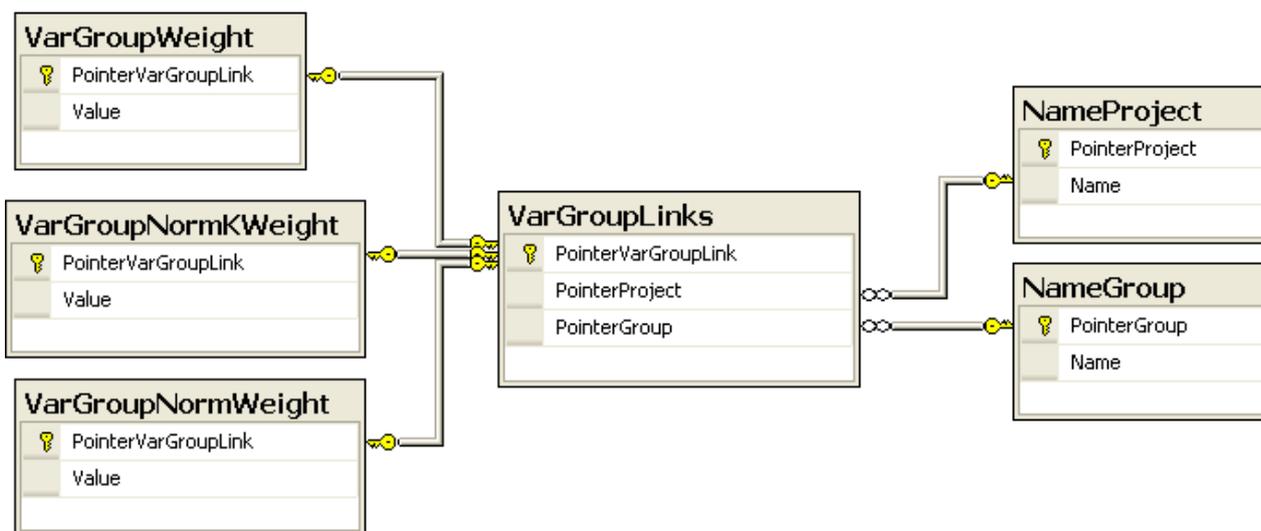


Fig. 10. Implementation of the plane "weight of a group of characteristics"

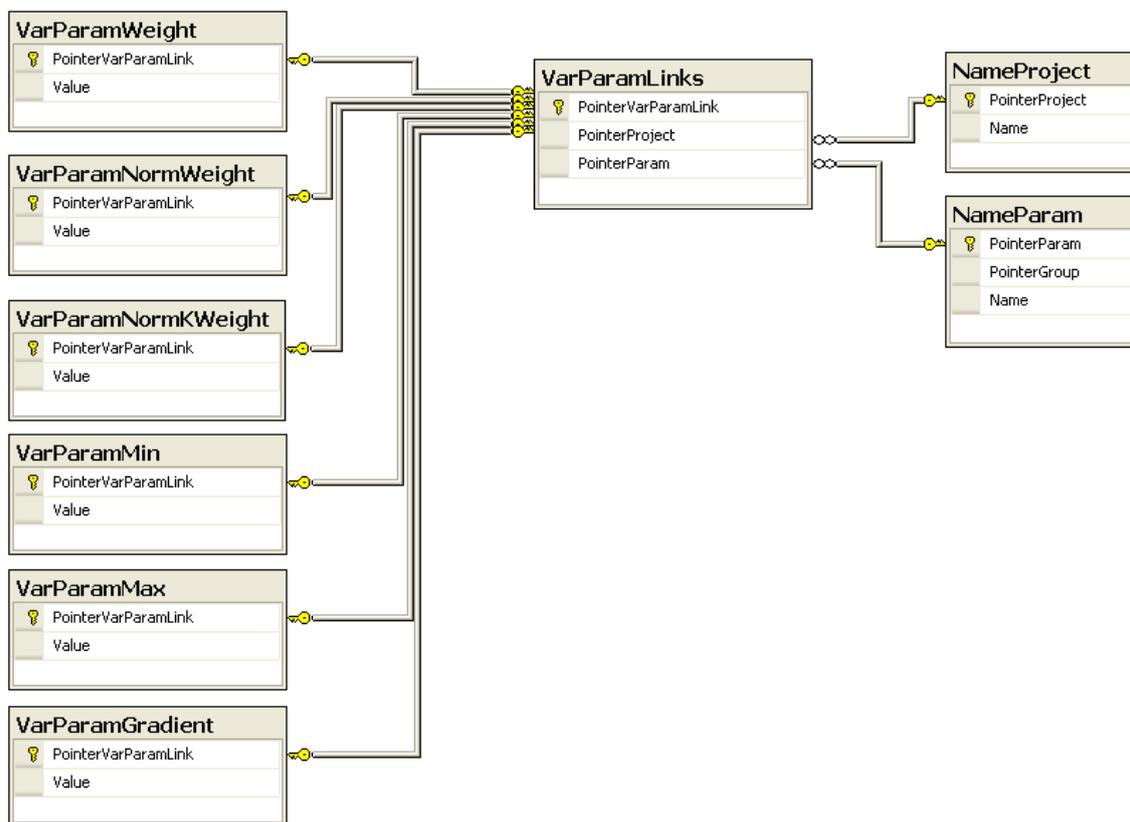


Fig.11. Implementation of the plane "Weight of characteristics"

Similarly realized all the remaining intermediate and output arrays interpretation in hypercubes. Figure 12 shows the window for selecting options analysis quality.

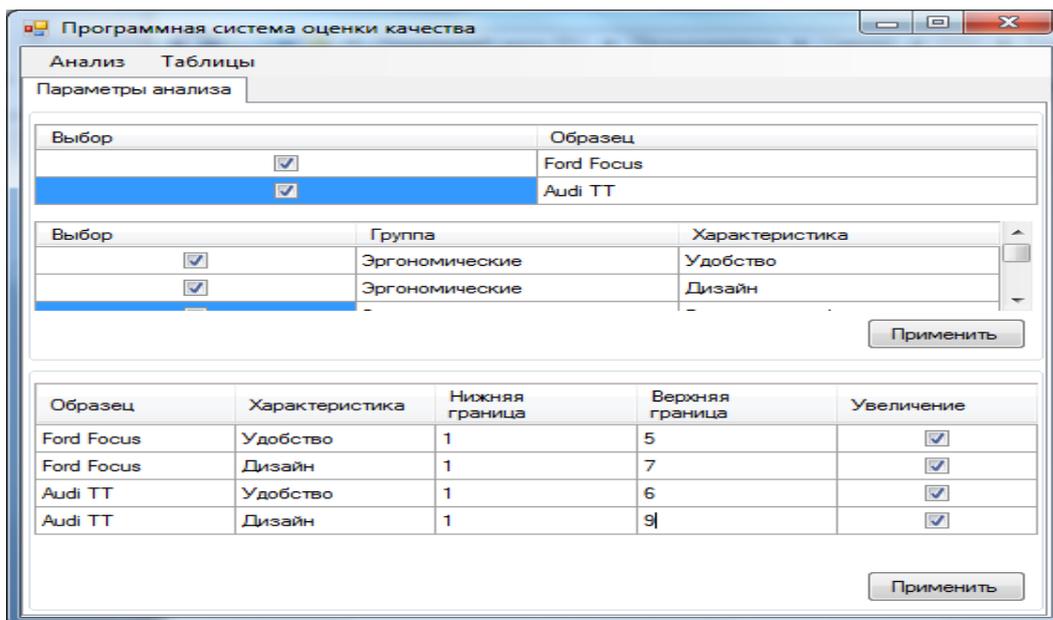


Fig. 12. The choice of analysis parameters

Figure 13 shows the results of quality evaluation of the two samples, and its representation in the form of a bar graph.

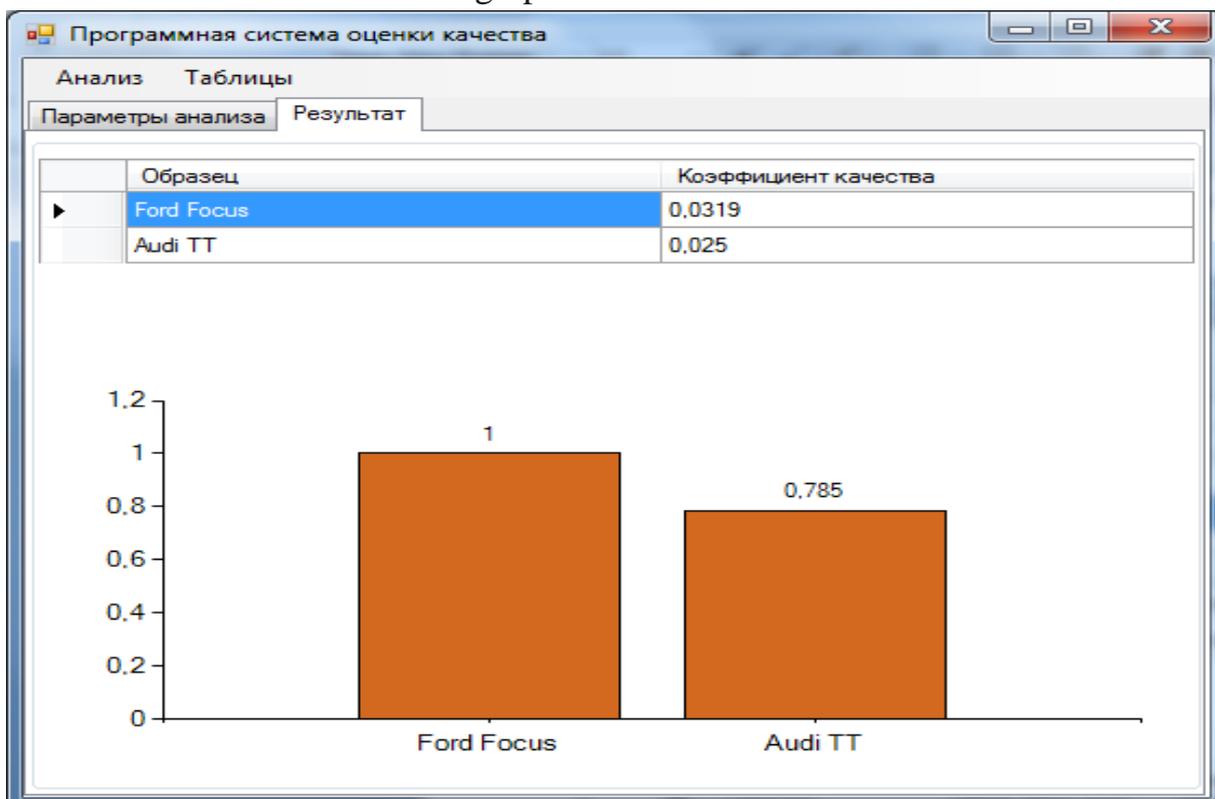


Fig. 13. The result of evaluating the quality

Since the object is constructed universal system of quality assessment, it is possible to perform calculations and research results in various areas. Figure 14 shows the results on the quality of teachers in the department, in Figure 15 - commensurate quality computer tools, in Figure 16 - Comparative analysis of levels of threat objects.

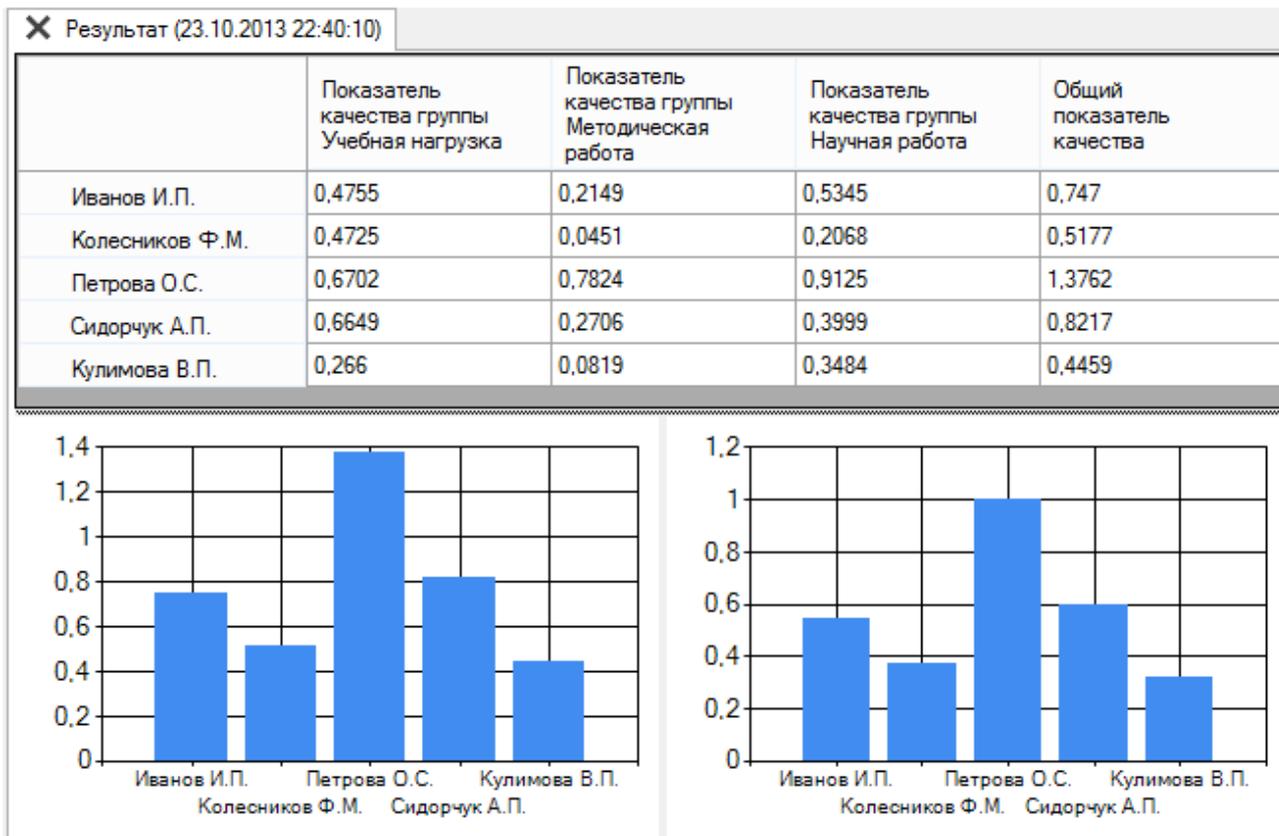


Fig. 14. Evaluation of the quality of teachers

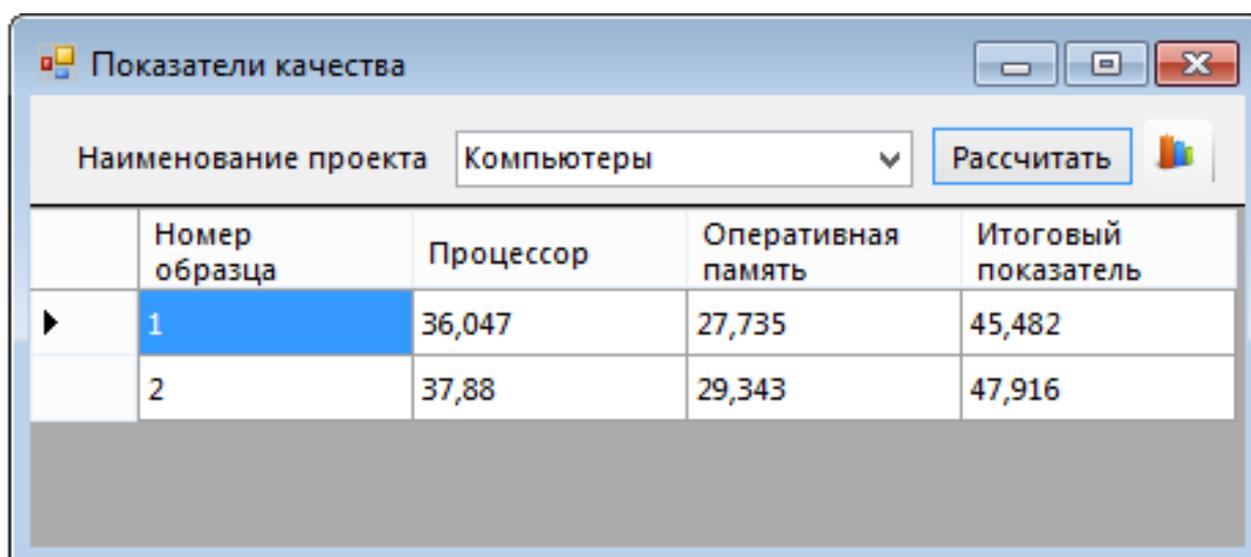


Fig. 15. Evaluation of the quality of computer resources

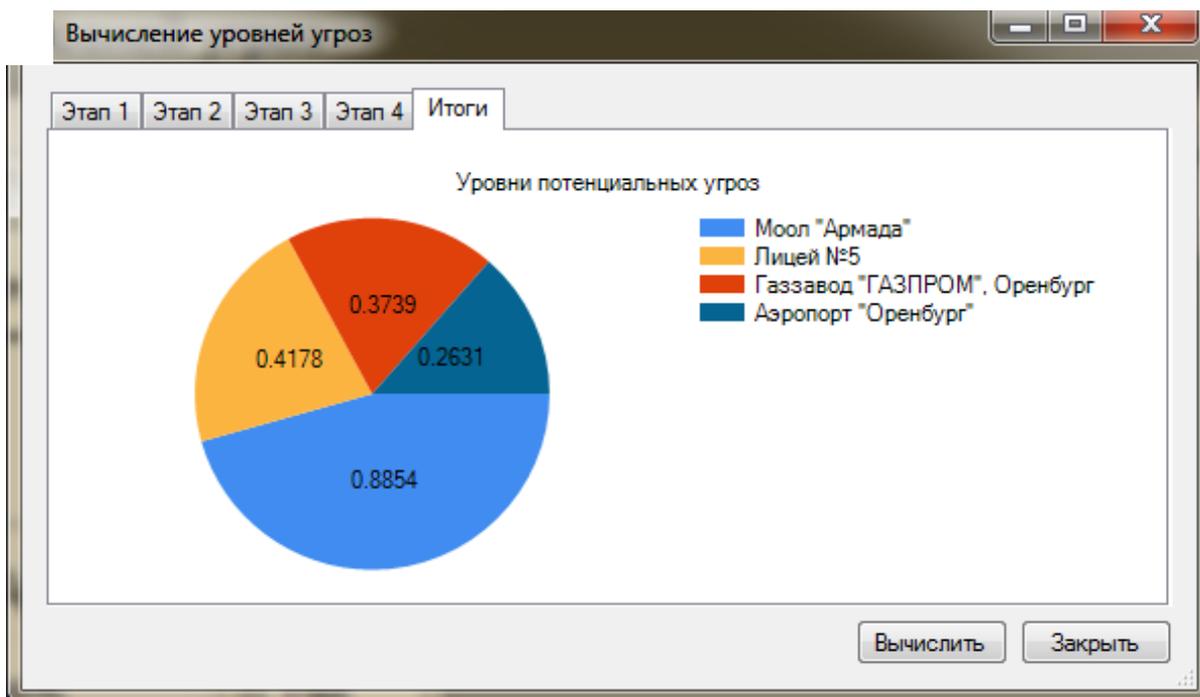
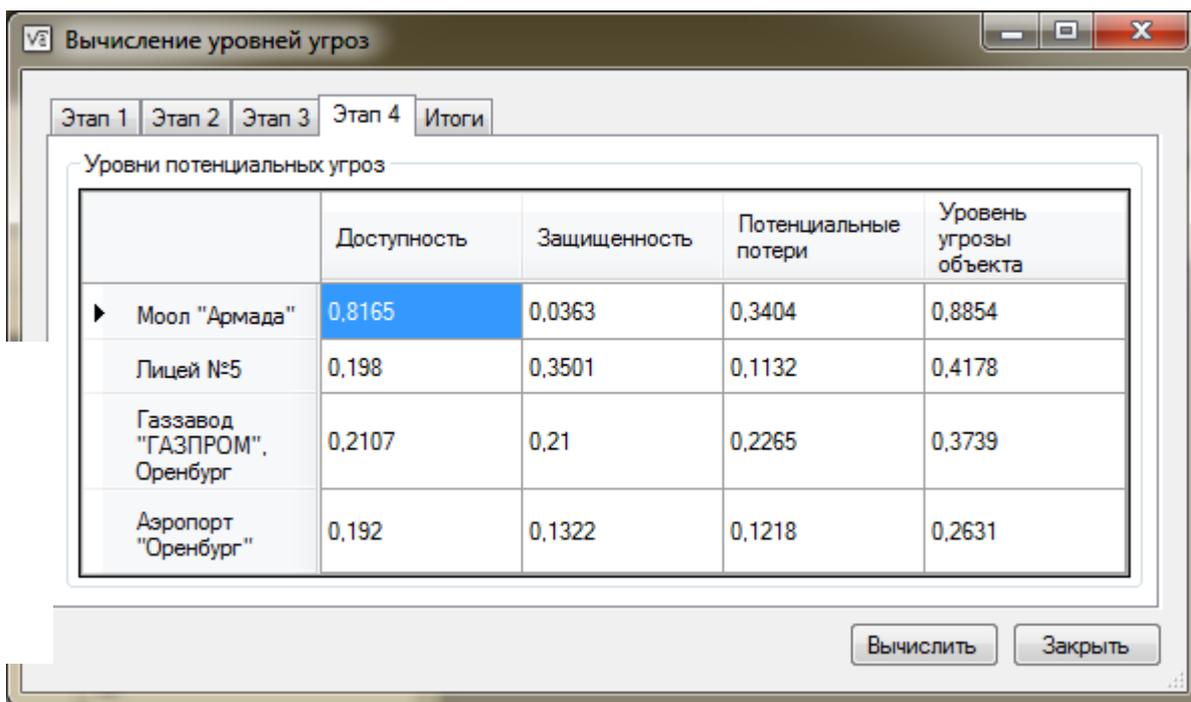


Fig. 16. Assessment of potential threats to objects

The considered method will allow to develop methodical bases of creation of information systems. Object-oriented formalism, and also advantages of means of object-oriented design and programming allow not only successfully model organizational structures in the form of systems of objects (agents), but also to build and dynamically developing structures. The agent system can formally be described as association of a variety of types of these T, the alphabet of events of X, sets of

identifiers of objects of I, classes (object models) With and objects About (the formalism is taken from materials of the European conferences on object-oriented programming of ECCOP):

$$S = (T, X, I, S, O).$$

For example, information system with self-organizing agent structure can be formalized as an joining of sets

$$S = (T; \text{AND}; I, \text{WITH} = \{ \text{Input, OUTPUT, FUNCTION} \}; \text{ABOUT}; O; \Pi)$$

where T — a set of types of data of object system; And — the alphabet of events of object system; I \ set of identifiers of objects; With = { Input, OUTPUT, FUNCTION } — a set of classes of structural elements (agents); About = {oi} — a set of elements of structure; Π — a set of rules of self-organization of this structure.

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J11510-024

Troshkov A.M., Bogdanova S.V., Ermakova A.N.
THE USE OF INFORMATION TECHNOLOGY TO SUPPORT THE
NORMAL BALANCE OF INDIVIDUALS AS A WAY TO INCREASE THE
PRODUCTIVITY OF THE HIVE

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For qualitative monitoring of bee colonies is proposed to automate the process of monitoring the operation of a biological organism - bee family and to maintain the balance of “drone bee”.

Key words: information technology, beekeeping, innovative technical product, the piezoelectric device.

The biological unity of bee society supported the complex relationships between all members of the bee family, with the normal functioning of the bee is achieved in full. All this allows the normal functioning of the colony and perform the duties by life extension. (fig. 1).

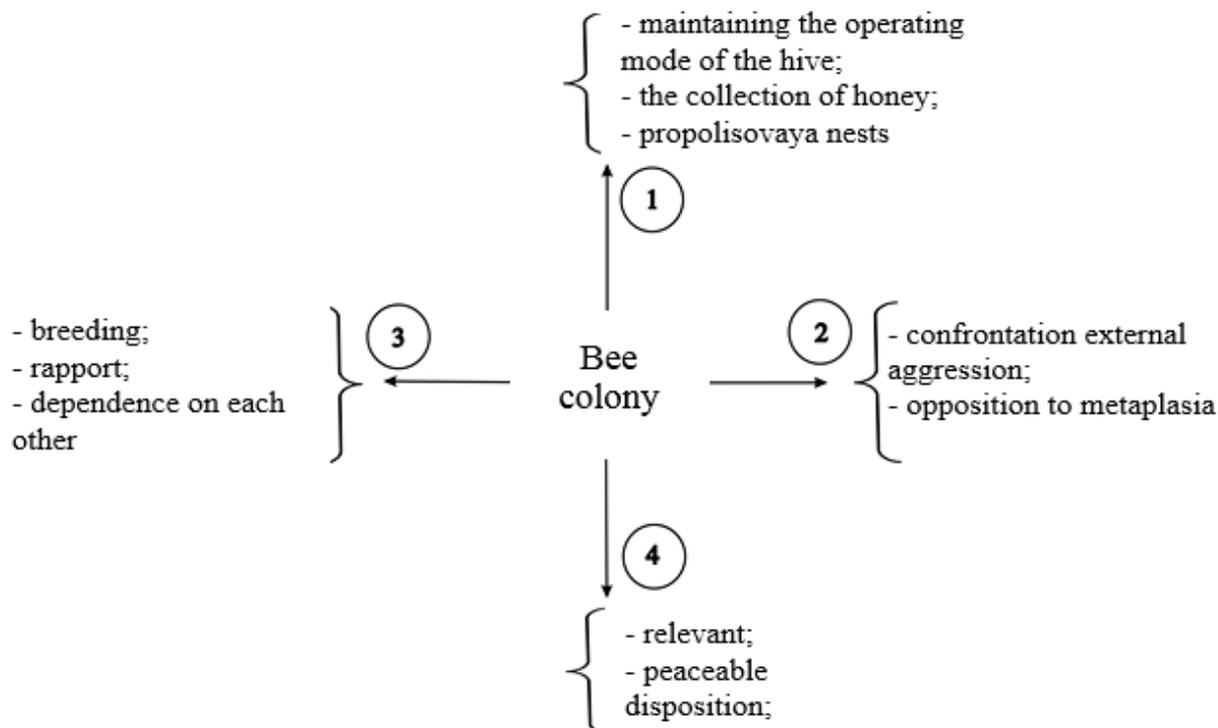


Fig. 1. The normal functioning of the hive

For the functioning of bee necessary complexity of operations, each member of a biological organism, maintaining the required quantitative balance of the family. The Queen bee has the function of procreation. Worker bees are the main members of the bee family and manufacturers main products of beekeeping. Drones have only one function - insemination of Queen bees for reproduction. On the rearing of drones spent 3 times as much feed.

Based on the analysis of the functioning of bee society - biological organism, requires constant monitoring of bee in the hive. Thus, the beekeeper constantly monitors the members of the bee.

Because the apiary bee colonies sufficiently large number, the beekeeper has no

way of quality monitoring. It is therefore proposed to automate the process control operation. Designed biometric characteristics of the members of the bee, are presented in table 1.

Table 1

Biometric characteristics

№	Members of the bee	length, L(mm)	mass of body, m(mg)	proboscis, <i>l</i>	head, Q	Wings, k
1	Queen	20-25	180-250	6,5	Large	S, Z
2	Working bee	12-14	100	7,25	Average	S, Z
3	Drone	15-17	200	3,5	Large	B

Table 1 presents a distinctive visual biometric characteristics L, m, l, Q, k are taken as the distinctive. Identify and calculate the number of individuals proposed to be made by means of visual control plane camera, which is mounted on the frame and moves with the help of thrusters in a matrix (rows, columns), it is connected to the RAM or USB arm beekeeper (fig. 2).

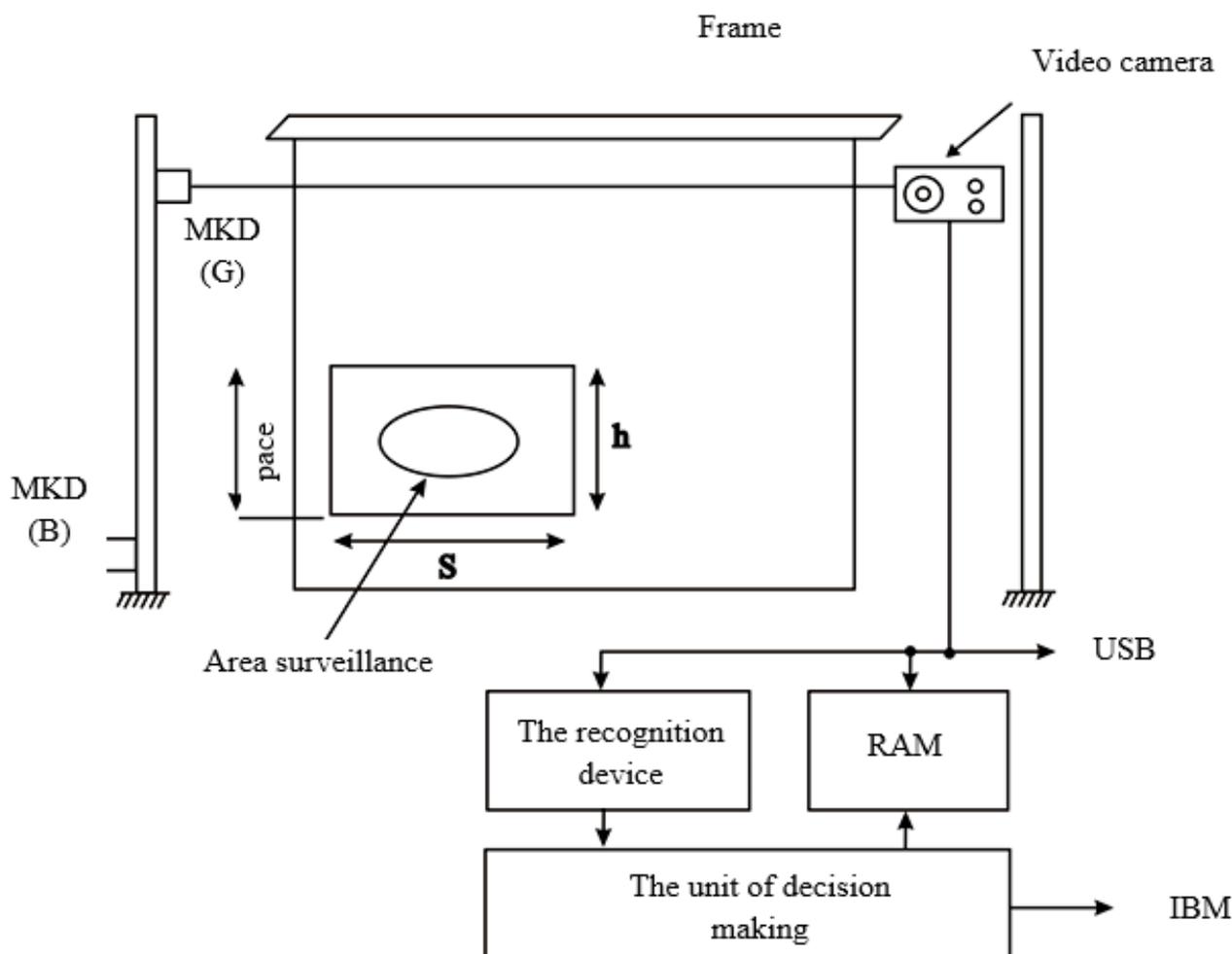


Fig. 2. Visual monitoring of the functioning of the biological society of bees

MKD (G) – the micro horizontal movement.
 MKD (B) – the micro vertical movement.

RAM – random access memory.

The work of visual monitoring is performed incrementally, scanning from top to bottom with a frame size of $S \times h$ (sm²).

Information is transmitted to the recognition device that identifies the biometric characteristics of the family members of the hive. RAM concentrates the information presented in table 2.

Table 2

Concentrated information bee

	Family members	Amount	All insects	Error recognition	The location of the uterus	The number of hundreds of drones
	Queen	M (шт)	N	%	m- lane	=
	Working bee	P (шт)		%		=
	Drone	T (шт)		%		j

According to the results of table 2 with AWP beekeeper, you can analyze the balance of bee colonies, and even to determine the amount of drone comb, which is thicker bee 5 mm.

So, for the preservation of honey and bee products, the necessary balance of drones and bees in the hive. If the number of drones after monitoring more than normal ($> N$), they shall be destroyed with the help of the device based on piezoelectric effect. The piezoelectric effect is explained as follows. In ionic crystals because of the different centers of positive and negative ions have an electric moment. When deformation of the crystal of positive and negative ions of the lattice are shifted relative to each other, changes the electric moment of the crystal. This change manifests itself in the piezoelectric effect, which is represented in the form:

$$U = Dd/d \tag{1}$$

где d - he thickness of the plate, Dd - its change during deformation.

The piezoelectric effect occurs not only under tensile strain, but when the shear strain. For the base device neutralization drones suggests using crystals, quartz or Rochelle salt, and crystals CdS, ZnS. Received from the piezoelectric effect of the stress is concentrated at the Executive element of the device from which is obtained a discharge in the form of spark scatter directional (fig. 3).

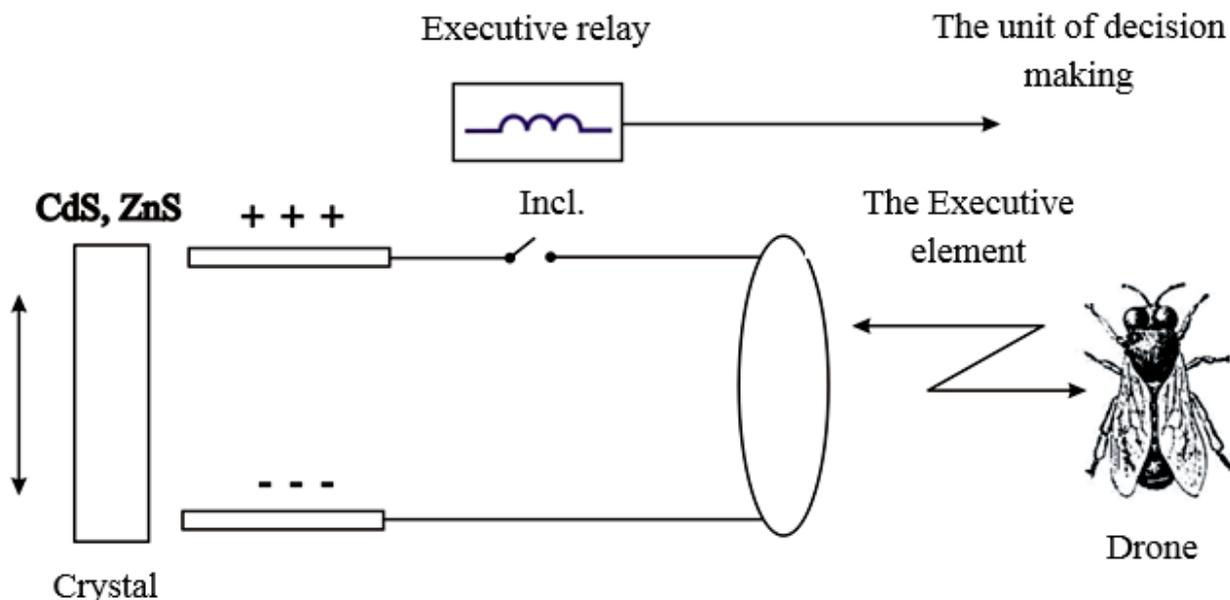


Fig. 3. The piezoelectric device

Thus, the piezoelectric effect is applicable in the conditions of limited power to neutralize drones. The piezoelectric device operates as follows. During the operation of neutralization drones piezoelectric device is attached to the camcorder, which is scanning and processing images of grub, bees, uterus. Upon detection of grub, information about the image is processed by a recognition device and transmitted to the decision, which generates a pulse signal for actuating the relay, and then in turn includes the switch and the actuator there is a discharge in the form of spark scatter directional. As a result, the drone dies, and the information comes in RAM, where is fixed. As with AWP beekeeper through the RAM, you can set the number of neutralizatsii, thus allowing a precise balance ratio drones and worker bees.

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© Troshkov A.M., Bogdanova S.V., Ermakova A.N.

J11510-025**Arefyeva D.Y., Logunova O.S.****CONCEPT OF SCIENTOMETRICS AND SCIENTOMETRIC INDICATORS***FSBEI HPE Nosov Magnitogorsk State Technical University,
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Abstract. The paper deals with the basic concepts of scientometrics and scientometric indicators. Attention is paid to the influence of scientometric indicators of the quality and quantity of produced items, there is job evaluation researcher.

Key words: scientometrics, scientometric indicators, h-index, impak-factor.

At present one of the most pressing problems is the evaluation of scientific activity to determine the contribution of individuals and groups in science. Russian Foundation for Basic Research designed and developed a system that includes a system of scientometric indicators such as the number of publications, h-index, number of citations, the number of co-authors, etc.

Project of the Russian Science Citation Index (RISC), which includes a national bibliographic database science citation, in place since 2006. At the moment it includes more than six million publications Russian authors (elibrary.ru) [5]. The project is designed to provide research information on the level of research and assesses the effectiveness and efficiency of scientists, organizations, magazines and publishing houses.

To evaluate the effectiveness of scientific activities used in the basic provisions of scientometrics and scientometric indicators. Scientometrics – area of knowledge concerned with the study of science statistical methods, studies the structure and dynamics of scientific publications [1]. Significant progress in the field of scientometrics contributed to the emergence of new information technologies, and with them increased and the number of scientific publications.

Scientometric indicators are a tool to rank researchers [2]. Every year the evaluation system of scientific activities are complemented by scientometric characteristics. For example, in the scientific electronic library for 2014 includes such factors as the h-index excluding self-citation, the number of publications in the Web of Science and Scopus, and others.

The main scientometric indicators Scientific Electronic Library (elibrary.ru) are:

– The number of citations of publications of the author in RISC – total number of references to the work of the author;

– The number of citations from magazines with nonzero Impak factor – accounted for references from magazines which have non-zero Impak factor ISI or Impak factor RISC;

– Hirsch index (H-index) – one of the most famous performance evaluation of a scientist and is determined depending on the number of publications and citations of works of the author. H-index has a non-zero value if the author has presented a number of articles, each of which holds so many links, and its other articles have a number of citations that do not exceed this number [3].

– Impak factor (IF) magazines – is a numerical coefficient, which indicates the

importance (relevance) of the journal [4]. The impact factor is a measure of the demand for publication of the magazine. At the moment in Russia is the task of raising Impak-factor journals, which are published and cited scientific papers. This can be done in different ways. For example, the publication of review articles, which often turn researchers.

Recently, much attention in the evaluation of research activities of institutions given such indicators as cited authors and journals in foreign scientometric systems (Web of Science and Scopus). In order to improve these indicators need to publish articles in journals that are indexed by these databases.

Database Web of Science founded Eugene Garfield in 1964. It represents the information tools that allow researchers to simplify the process of evaluating their contribution to science, as well as trace the history of the development of modern scientific thought. Today, access to the Web of Science through a special Web-platform, called the Web of Knowledge. For inclusion in the journal Web of Science focuses on criteria such as content publishing, text readability, the frequency of the output, the relevance of the information provided in the articles. The disadvantage of the base Web of Science for Russian authors is the idea of publications in English only.

Scopus – it scientometric database peer-reviewed literature, which is the largest collection of essays, research, quotes and books in various fields of science. Scopus is a relatively new (2004) database with respect to the Web of Knowledge. Unlike Web of Science of the database is not used Scopus Impak factor notion, but widespread use of it found in Hirsch index. This system takes scientific articles and publications on the following criteria:

- Publication of the article should have a name in English, as well as their content;
- Publication must publish new issues at least once a year;
- In the publication must be present international scientific authority;
- Availability, popularity (number of links on the edition) articles and publications;
- In the edition to be your website.

Thus, scientometric systems contain a system of indicators that perform quantitative evaluation of scientists around the world and individual countries. Modern scientific and educational organizations have access to the results of research that allows you to expand scientific cooperation between scientists, organizations and enterprises, creating extensive collaboration to achieve common goals.

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J11510-026

Danenko V. F., Gurevich L. M., Nikitin V. A., Shatalin S. Yu.
ON INCREASING THE UNIFORMITY OF DISTRIBUTION OF A
CLADDING LAYER AROUND THE CORE BIMETALLIC ROD
DURING HOT ROLLING

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Introduction. The main industrial method of production of bimetallic rods is hot rolling. According to the scheme of this method previously prepared bimetallic billet round cross-section, consisting of a core and a shell, after heating in the furnace is rolled in the system calibers of rolling stands. An important role in improving the quality of the finished product plays the uniformity of the cladding layer around the core.

Objective: the choice of calibers initial rolling, ensure uniform distribution of a cladding layer around the core in bimetallic rolled wire with a reliable welding component on the contact surfaces.

The feasibility of the study showed the following experiment. Hot rolling the composite billet with a diameter of 50 mm (core of steel 45, the shell of steel 12Cr18Ni10T) bimetallic rod carried on the bar mill on the existing system calibers «oval – square» [1]. The advantage of the exhaust system «oval – square» is the ability to achieve high exhaust (oval passes to 2.2, and in square to 1.5). The heating temperature of the billet for rolling at the time of issuance of the heating furnace was 1150°C.

Technology of production of bimetallic rod provides high bonding strength of the layers, however, the border connection layers had a complex contour (fig. 1), due to uneven strain, and overflow calibers at the initial stage of rolling due to a mismatch of cross-sectional sizes of the original team billet existing calibration rolls.

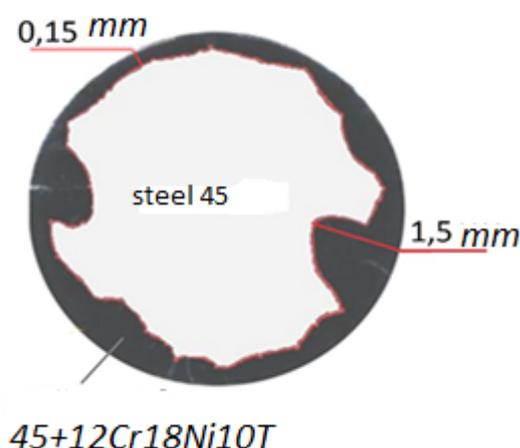


Fig.1. The shape of the boundary layers in the cross section of the bimetallic rod

In the present work a comparative analysis of the distribution of a cladding layer around the core was performed by simulation of the rolling process when the selected systems calibers.

Test method for modeling the possibility of obtaining a relatively constant thickness of the cladding layer by rolling round bimetallic billet system calibration «square-oval-circle» showed [3] changing the thickness of the coating on the contour finishing range between 8-10%.

Enjoy hot rolling round bimetallic billet initially implement the system «circle – circle» in the three-roll calibers [2]. In the absence of broadening of the metal is a comprehensive uniform compression of the layers of the work piece, which ensures adhesion of the components over the entire contact surface and uniform distribution of a cladding layer around the core.

The assessment of uniformity a cladding layer around the core is carried out by rolling in two calibers, believing that the simulation results will allow us to estimate the necessary conditions of deformation in the three-roll calibers. Building calibers were conducted by the method [4]. However, in order to avoid overflow of the caliber and the formation of burrs horizontal diameter of the caliber took 1-2% more vertical.

The temperature of the hot rolling was chosen 1150°C. To calculate the dependence of the yield stress from the deformation rate used kinetic curves of strain hardening of steel 45 and 12Cr18Ni10T [5]. For three-dimensional (3D) simulation of the rolling process of a bimetallic billet on selected passages used software package SIMULIA/Abaqus. Mill rolls were made rigid with a fixed position of the axes. The coefficient of friction between rotating with constant angular velocity 6,28 rad/s rollers and the surface of the steel 12Cr18Ni10T in accordance with [4] adopted $f = 0,2$. Moving rolled billets produced force with a speed of 2 m/s the size of the side of the cubic cell of the grid was chosen to 2.0 mm, which provides sufficient accuracy in an acceptable computation time.

At the first stage to simulate the rolling of bimetallic billet steel 45+12X18H10T 50 mm in diameter were selected two passes with a single compression of 15%. The contours of the work piece in the middle section of the deformation zone on the simulation results shown in fig. 2.

The figure shows that after the first passage, the formation of the Burr and the gap between the layers (fig. 2, a), and after the second passage to the distortion of the circular cross-section in the area of contact of the core and shell in the horizontal direction and the formation of the Burr and the gap between layers in the vertical direction (fig. 2, b).

In the second stage to simulate the rolling of bimetallic billets were selected passages with a single compression 12%. The contours of the work piece in the middle section of the deformation zone at the selected systems calibers shown in fig.3. The figure shows that the decrease of the degree of compression significantly reduces the extrusion of metal between the shoulders caliber in the horizontal direction and prevents the formation of a gap between the shell and core during the first pass (fig. 3, a). However, on the second pass there is extrusion of metal between the shoulders caliber and partial curvature of the contour of the interface between the shell and core (fig. 3, b).

Due to the relatively small exhaust system's ability calibers «circle - circle» limiting values hoods to 1.09-1,18 (compression 8-15 %) [4], modeling of rolling the work piece in the second pass was made in the calibers «round – oval». As can be

seen from fig. 3, c, for this case when the deformation of the intermediate profile provides uniform distribution of shell thickness around the core and the lack of clearance between the shell and the core.

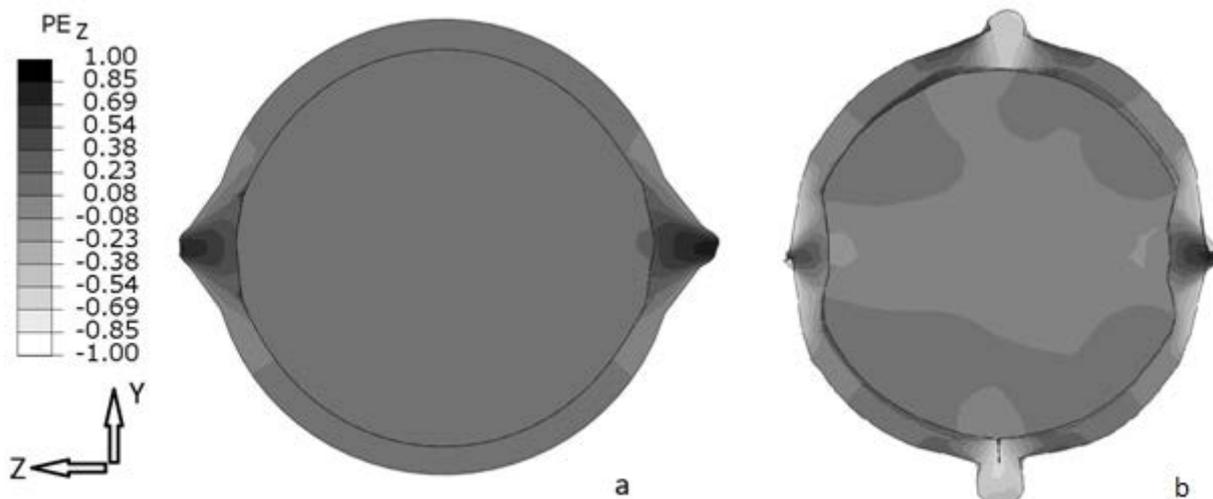


Fig. 2. The contours of the surface of the work piece and the layer boundary after the first (a) and second (b) passes in a single compression 15 %

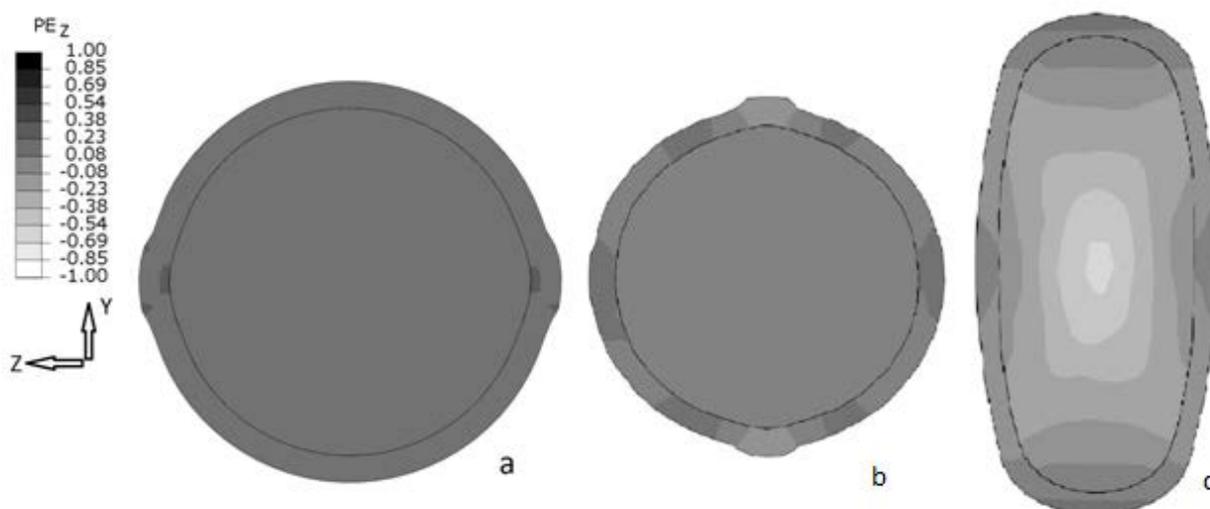


Fig. 3. The contours of the surface of the work piece and the layer boundary after the first pass through the system gauges the circle-the circle (a), second pass through the system gauges the circle-the circle (b) and circle-oval (c) at the single compression 12 %

When considering the reliability of the welding components on the contact surfaces, while reducing the number of passes the initial rolling of the work piece proceeded as follows. In the usual processes of joint hot plastic deformation of a bimetallic billet for reliable connection of layers needed to make multiple passes through the system calibers «circle-circle», which leads to the complexity of the process rolling. Reducing the number of passes to a minimum and ensuring the quality of the weld metal shell core is possible using the effect of super plasticity [6]

for the intensification of the connection.

Conclusion

The simulation of the rolling process of a bimetallic billet steel 45+12Cr18Ni10T steel shows the uniformity of the shell thickness around the core and the lack of clearance between the shell and the core when performing rolling in the first pass through the system calibers «circle - circle», that is stored in the further rolling on having a large exhaust capacity of the system calibers «round – oval».

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J11510-027

Ryzhkova T.N., T.A. Bondarenko, I.M. Livoshchenko
IODINE CONTENT IN GOAT'S MILK FROM THREE REGIONS OF
UKRAINE

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Summary. The comparative results of the investigation of the physical and chemical composition of the samples of goat's milk including the content of iodine in it have been presented in the article. The samples were taken from the goats kept in three regions of Ukraine in different seasons.

It has been established that the samples of milk from the goats of the AR Crimea had the highest content of iodine and the lowest value was in the samples of milk from the goats of Lvov region.

The content of iodine in the samples of milk from the goats of Kharkov region was in accordance with the standard that is necessary to use the milk in the rational dietary of the people of the country.

Key words: goat's milk, physical and chemical indices, iodine.

I. INTRODUCTION. In Ukraine more than 15 millions people live in the territories that are endemic by iodine [1]. The most expressed natural iodine deficiency is observed in the western regions of Ukraine. This territory is presented by the different climatic and geographical areas (mountains, foot hills, plains). By the classification of the World Health Organization the people of the above regions have the expressed (medium degree of severity) deficiency of iodine in the ration but in some populated areas the above index approaches to the severe iodine deficiency. However, all the other territories of Ukraine are also in the area of iodine deficiency but less expressed.

All the plants that grow on the iodine deficient soil will have the insufficient content of iodine and iodine deficient diseases develop in the people and animals because their diet depends on the food grown on the above soil.

The main source of iodine for people is food. The highest concentration of iodine has been detected in sea fish and sea products. Animal products – milk, eggs and meat - have relatively high content of iodine. The concentration of iodine in milk and animal products greatly depends on the fact if the iodized salt or other feed additives enriched by iodine are used when animals are on fattening.

In accordance with the standards of the rational dietary of the people the intake of iodine per day is 100-200 mcg on average and for the pregnant women and nursing mothers – 250 mcg [2]. So, the aim of the investigation was to study the effect of the climatic and geographical areas on the changes of the physical and chemical composition of the samples of goat's milk including the content of iodine.

The actuality of the article was to make the comparative analysis of the obtained results of the investigations of the physical and chemical parameters of the samples of goat's milk including the content of iodine in different seasons. The samples were

taken from the goats kept in three regions of Ukraine: Kharkov, Lvov and the Autonomous Republic of the Crimea.

MATERIALS AND METHODS. The determination of the mass rate of fat, protein, lactose, dry matter, dry skim milk residue (DSMR) was done instrumentally by the device “Bentley -150” in % in accordance with the requirements of ISO 9001:2000. The determination of the content of iodine in milk was done by the titrimetric method in compliance with the requirements of SSTU (GOST of Ukraine) 4816: 2007: “Food stuffs. Total iodine content determination methods”.

RESULTS AND DISCUSSIONS. The groups of goats of Saanen and mixed local breeds, 10 heads in each group, were formed in three regions of Ukraine: Kharkov, Lvov and the Autonomous Republic of the Crimea.

The mean daily samples of milk were taken by the seasons and the investigation of the physical and chemical composition of the samples of goat’s milk including the content of iodine was carried out. The results of the study are given in Table 1.

It can be seen from Table 1 that in winter the experimental samples of milk from the goats of Lvov region and AR Crimea had the lower content of fat by 1,47% and 0,32 %, respectively, ($P \geq 0,95$) as compared to the analogous value of the milk sample from the goats of Kharkov region.

In spring the samples of milk from the goats of AR Crimea were different from the samples of milk from the goats of Kharkov and Lvov regions by the mass rate of fat in the samples by 0,39% and 1,14% ($P \geq 0,95$).

In the summer period of time there was the same tendency. The mass rate of fat in the samples of milk from the goats of AR Crimea exceeded the analogous index of the samples of milk from the goats of Kharkov and Lvov regions by 0,54% and 0,67 %, respectively, ($P \geq 0,95$).

In autumn the content of fat in the experimental samples of milk from the goats of Lvov region was lower by 0,67% ($P \geq 0,95$) as compared to the analogous value of the milk sample from the goats from Kharkov region. There was no trustworthy difference between the content of fat in the samples of milk from the goats of Kharkov region and the analogous value of the milk sample from the goats of AR Crimea ($P \geq 0,95$).

In winter the content of protein in the experimental samples of milk from the goats of AR Crimea was lower by 0,25 % as compared to the analogous value of the milk sample from the goats of Kharkov region ($P \geq 0,95$). There was no trustworthy difference between the content of protein in the samples of milk from the goats of Kharkov and Lvov regions ($P \geq 0,95$).

In spring, summer and autumn the content of protein in the experimental samples of milk from the goats of Lvov region was lower by 0,47; 0,57 and 0,12%, respectively, ($P \geq 0,95$) as compared to the analogous value of the milk sample from the goats of Kharkov region. There was no trustworthy difference between the content of protein in the samples of milk from the goats of Kharkov region and AR Crimea in the above seasons ($P \geq 0,95$).

In winter the experimental samples of milk from the goats of AR Crimea had the higher content of lactose by 0,42 % as compared to the analogous value of the milk sample from the goats of Kharkov region ($P \geq 0,95$). But the samples of milk from

the goats of Lvov region had the lower content of lactose by 0,18 % as compared to the analogous value of the milk samples from the goats of Kharkov region ($P \geq 0,95$).

In spring the samples of milk from the goats of AR Crimea had the lower content of lactose by 0,24 % as compared to the analogous value of the milk samples from the goats of Kharkov region ($P \geq 0,95$).

No trustworthy difference between the content of lactose in the samples of milk from the goats of Kharkov and Lvov regions was detected ($P \geq 0,95$).

In the summer period of time the mass rate of lactose in the samples of milk from the goats of Lvov region and AR Crimea was lower by 0,5 and 0,29%, respectively, ($P \geq 0,95$) as compared to the analogous value of the milk sample from the goats of Kharkov region.

In autumn the samples of milk from the goats of Lvov region and

AR Crimea had the lower content of lactose by 0,19 and 0,26% ($P \geq 0,95$) as compared to the analogous value of the milk samples from the goats of Kharkov region.

In Kharkov region: the difference between the content of iodine in summer and in winter periods was 28,0 mcg/kg ($P \geq 0,99$).

The content of iodine in the samples of milk in summer was higher by 12 and 16 mcg/kg, respectively, ($P \geq 0,95$) as compared to the analogous value of the samples of milk produced in spring and autumn.

In Lvov region: no trustworthy difference between the content of iodine in the samples of milk produced in all the seasons was revealed ($P \leq 0,95$).

In the Autonomous Republic of the Crimea: the highest content of iodine was detected in the samples of summer milk and the lowest content was in the winter milk. The difference was 59 mcg/kg ($P \geq 0,99$). The content of iodine in the samples of milk in summer was higher by 29 and 34 mcg/kg as compared to the spring and autumn milk ($P \geq 0,99$).

The difference between the levels of iodine in the milk of the goats in AR Crimea in summer as compared to the analogous indices of milk samples from the goats kept in Kharkov and Lvov regions was 47 and 162 mcg/kg, respectively.

The difference between the levels of iodine in the milk of the goats in AR Crimea in winter as compared to the analogous indices of milk samples from the goats kept in Kharkov and Lvov regions was 76 and 114 mcg/kg, respectively.

CONCLUSIONS.

1. The results of the comparative analysis of the physical and chemical indices of the milk samples in different regions of Ukraine have proved that the climatic and geographical areas have an influence on the physical and chemical composition including the content of iodine in it.

2. The highest content of iodine was in the samples of milk from the goats kept in AR Crimea in all the seasons as compared to the analogous value of the milk samples from the other regions of Ukraine.

3. The lowest content of iodine was in the samples of milk from the goats kept in Lvov region in all the seasons as compared to the analogous value of the milk samples from the other regions of Ukraine.

4. The content of iodine in the samples of milk from the goats kept in Kharkov

region is in compliance with the standards of the rational dietary of the people of the country.

5. It is recommended to introduce iodine-containing additives into the ration of goats in the regions with low content of iodine in milk including Lvov region. It is necessary to use the iodized goat's milk and fermented food stuffs produced on its basis including rennet cheese, cottage cheese and sour milk drinks in the dietary of the people.

Table 1

Physical and chemical indices of goat's milk samples by seasons

Name of the object under investigation	Season	Indicator				Content of iodine, mkg/kg
		M. r. fat, %	M. r. protein, %	M. r. lactose, %	M. r. dry matter, %	
Milk produced from goats in Lvov region	Autumn	4,28±0,01	3,31±0,01	4,63±0,09	13,12±0,07	38±0,75
	Winter	4,13±0,02	3,81±0,1	4,74±0,02	13,61±0,02	36±1,11
	Spring	3,35±0,02	2,94±0,01	4,81±0,01	12,02±0,02	42±1,11
	Summer	3,39±0,02	2,80±0,02	4,32±0,02	11,51±0,02	47±1,60
Milk produced from goats in Kharkov region	Autumn	4,95±0,36	3,43±0,22	4,56±0,33	13,74±0,48	86±1,58
	Winter	5,6±0,1	3,6±0,10	5,38±0,34	15,0±0,40	74±1,29
	Spring	4,10±0,24	3,41±0,21	4,50±0,30	13,8±0,45	90±1,15
	Summer	3,52±0,23	3,37±0,20	4,58±0,32	12,5±0,49	102±1,62
Milk produced from goats in AR Crimea	Autumn	4,88±0,32	3,49±0,24	4,56±0,33	13,81±0,45	175±1,94
	Winter	5,28±0,30	3,65±0,13	5,34±0,31	15,15±0,41	150±1,72
	Spring	4,49±0,27	3,42±0,22	4,49±0,29	13,28±0,40	180±1,54
	Summer	4,06±0,21	3,45±0,23	4,53±0,32	12,92±0,39	209±1,92

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THEORETICAL BASIS OF FLUSHING BIODIESEL

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Abstract: The dynamics of deposition plates aqueous solution of potassium citrate and water droplets in the bulk of biodiesel. The settling time of their deposition. Defined rational water droplet sizes for washing biodiesel

Keywords: plate potassium citrate, biodiesel, water droplets, Reynolds, the deposition rate

Introduction. Neutralising biodiesel citric acid are formed salts (citrate) calcium, which together with water are connected in a plate shape similar to the shape of a cylinder with a maximum diameter of about 1,5-3 mm. When mixing of biodiesel during the neutralization of these plates are broken down into smaller maximum diameter of approximately 50 μm . The ratio of the height of the plate an aqueous solution of potassium citrate to its diameter is approximately 1/10 the density of the 1237 kg/m^3 .

After neutralization with calcium salts to withdraw from biodiesel to reduce its alkalinity. This can be done by deposition.

Анализ последних исследований. On the particle, which is in fluid in a vertical channel, are: gravity $P_g = m_q g = V_q \cdot \rho_q \cdot g$ [1], the force of Archimedes $P_A = V_q \cdot \rho_p \cdot g$ [2], where M_q – the mass of particle, kg; V_q – the particle volume, m^3 ; g – the acceleration of gravity, m/s^2 ; ρ_q , ρ_p – the density of the particle and fluid, respectively, kg/m^3 .

If $P_g > P_A$, the particle starts to fall in the bulk liquid. The force acting on the particle at this point is:

$$P_g - P_A = V_q \cdot \rho_q \cdot g - V_q \cdot \rho_p \cdot g = V_q \cdot g \cdot (\rho_q - \rho_p). \quad (1)$$

When the motion of the particle to the bottom of the tank it starts acting drag force opposing the difference of the forces $P_g - P_A$: $P_o = \zeta \cdot S_q \cdot [(\rho_p v_q^2)/2]$ [1], where ζ – coefficient of resistance; S_q – the projected area of a particle on the horizontal plane, m^2 ; v – the velocity of the particle, m/s .

At the initial deposition, the particle moves with acceleration. But with increasing speed will increase the resistance of the medium and consequently to decrease the acceleration. Very soon will come the equilibrium: the force of resistance of the environment P_o compare with the power of moving particles ($P_g - P_A$) and will come to a dynamic equilibrium: $P_o = P_g - P_A$. From this point, the particle will move uniformly with constant speed. This speed is called the deposition rate v_{oc} .

The deposition rate can be found from the condition of equality of the forces driving the particle, and the force of resistance environment $P_g - P_A = P_o$ [2]:

$$V_q \cdot g \cdot (\rho_q - \rho_p) = \zeta \cdot S_q \cdot [(\rho_p v_q^2)/2]. \quad (2)$$

Hence the settling velocity of particles is:

$$v_{oc} = \sqrt{\frac{2 \cdot V_u \cdot g \cdot (\rho_u - \rho_p)}{\zeta \cdot S_u \cdot \rho_p}} \quad (3)$$

Coefficient of resistance ζ depends on the mode of motion of a particle in the deposition of $\zeta=f(\text{Re})$, which is characterized by the Reynolds criterion [2]:

$$\text{Re} = \frac{\rho_p d_u v_{oc}}{\mu_p}, \quad (4)$$

where Re – Reynolds criterion; d_u – the particle diameter, m; μ_p – the dynamic viscosity of the liquid, Pa·s

There are different modes of deposition of particles, each of which corresponds to a certain value of the Reynolds criterion Re .

In laminar mode $\text{Re} < 2$ the ratio of the resistance of the environment is defined as $\zeta = 24/\text{Re}$. With the development of turbulent flow begin to appear local turbulence and transition zone occurs ($\text{Re} = 2-500$). The coefficient of the resistance of a medium is defined as $\zeta = 10/\text{Re}^{0.5}$. Since some values of the Reynolds criterion, when fully developed turbulent flow in $500 < \text{Re} < 2 \cdot 10^5$, the frictional resistance can be neglected, since the main force becomes a drag. For the turbulent region the ratio of the resistance of the environment is $\zeta = 0,44$ [2]. When $\text{Re} \geq 2 \cdot 10^5$ the crisis resistance, and the value is sharply drops (4-5 fold) [3]. Given values ζ fair when the motion of a particle in the shape of a ball.

For other bodies of regular geometric shape of the experimental values ζ not amenable to exact generalization of empirical formulas. With some approximation, we can calculate the value ζ for particles of irregular geometric shapes in the above formulas for spherical particles using the sphericity coefficient φ_c , the value for particles of cylindrical shape range $h = (1/2) \cdot d \dots (1/30) \cdot d$ can be approximated by the expression $\varphi_c = (0,2233 \cdot \ln(a) + 0,9869)$ when $R^2 = 0,9993$, where a – the multiplier in the range from 1/2 to 1/30.

The coefficient of non-spherical particles for the laminar regime is $\zeta = 28,47 / [\text{Re}_e \cdot \lg(\varphi_c / 0,065)]$, where Re_e – the equivalent Reynolds criterion, which is defined as $\text{Re}_e = (\rho_p d_e v_{oc}) / \mu_p$, where d_e – the equivalent diameter is equal ball, m Equivalent diameter equal of the ball is determined from the expression $d_e = \sqrt[3]{6 \cdot V / \pi}$. For turbulent regime the coefficient of non-spherical particles is defined as $\zeta = 5,31 - 4,87 \cdot \varphi_c$ [3]. In the area of the transitional regime for non-spherical particles is recommended to use a value ζ , listed in [3, c. 70]. They can be approximated by the expression $\zeta = 19,848 \cdot \text{Re}_e^{-0,3858}$ when $R^2 = 0,899$.

However, in practice, formula (3) difficult to use, because it includes a coefficient that depends on the Reynolds number and mode of motion of a particle. At the same time, the mode of motion of the particle and the Reynolds number, in turn, depend on the deposition rate. Therefore, **the aim of our research** is to develop a mathematical model of the deposition plates of an aqueous solution of citrate of potassium, which will allow you to set and optimize the speed and time of their deposition.

The results of the research. Due to the difficulty of applying the formula (3), the deposition of particles in the bulk liquid is useful to consider the dynamics. According to [1], the equations of motion of particles in the bulk liquid can be recorded through a system of differential equations:

$$\begin{cases} m_q \frac{dv_q}{dt} = P_o - (P_g - P_A) \\ \frac{dl_\kappa}{dt} = v_q \end{cases} \quad (5)$$

where l_κ – is the length of the channel (distance, which passes particles deposition in the thickness of biodiesel), m.

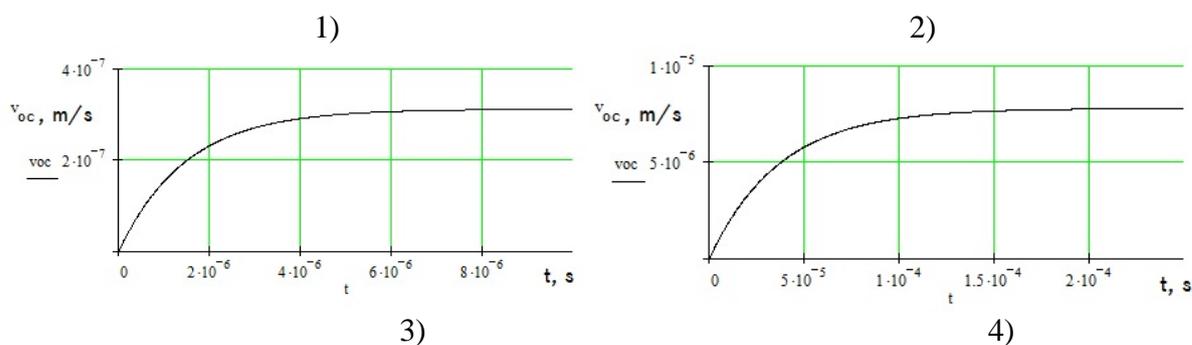
Substituting in the expression (5) the values of the forces of gravity, drag and Archimedes, we get the system of differential equations describing the deposition of particles in the thickness of the static fluid located in the bore of D_κ :

$$\begin{cases} \frac{dv_q}{dt} = \frac{\zeta \cdot S_q \cdot \rho_p \cdot v_q^2 \cdot \left(1 - \left(\frac{d_q}{D_\kappa}\right)^2\right)}{2 \cdot m_q} - \frac{V_q \cdot g \cdot (\rho_q - \rho_p)}{m_q} \\ \frac{dl_\kappa}{dt} = v_q \end{cases} \quad (6)$$

By solving the system of equations (6), received dynamics of change in time of the deposition rate of particles, its Reynolds number and the time of deposition.

Dynamics of change of the deposition rate of the plates of an aqueous solution of potassium citrate in time is shown in Fig. 1. As can be seen from the table 1, plate diameter ranging from 10 μm to 100 μm are deposited in laminar mode, because $Re < 2$.

The deposition rate of the plates of an aqueous solution of potassium citrate is gradually growing, as can be seen from Fig. 1. After stopping the mixer force of gravity acting on the plate, gradually begins to exceed the Archimedes force and effect resistance, the deposition rate increases according to the law, is close to linear. However, starting from some point in time, due to increased resistance, the acceleration of the plate decreases and at a certain point, when the force of gravity is balanced by the Archimedean force and power of resistance, the deposition rate is stabilized.



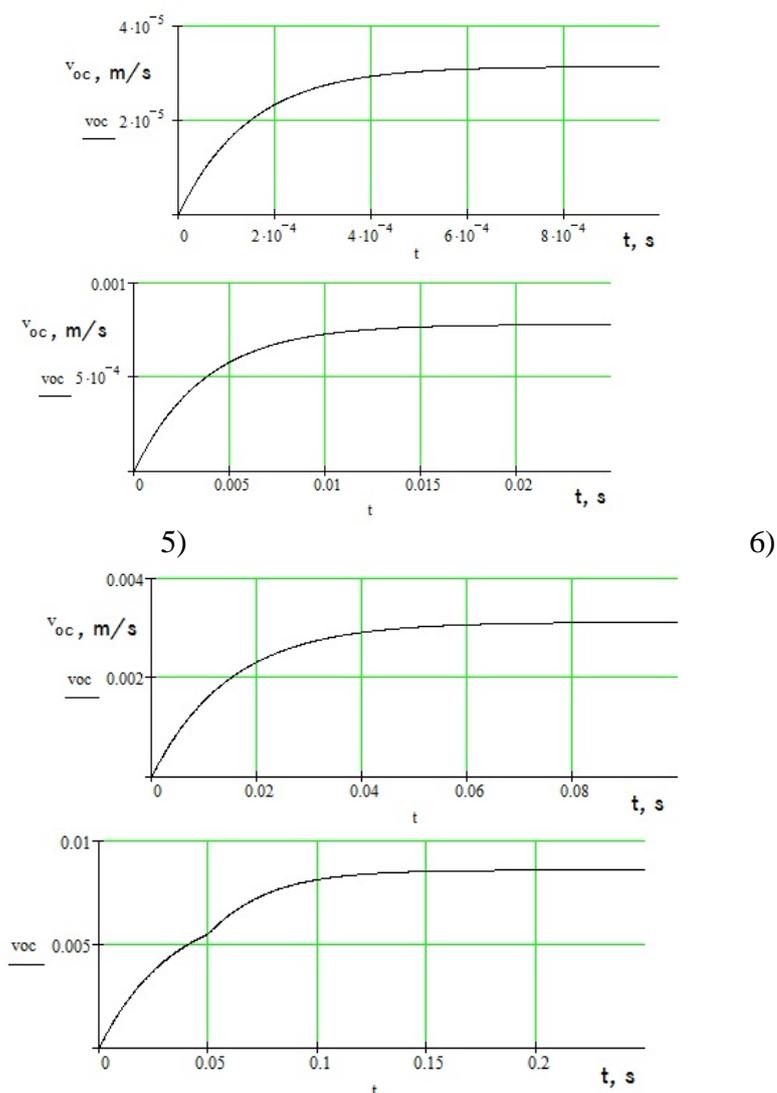


Fig. 1. The deposition rate of the plates (the ratio of height to diameter 1/10) of an aqueous solution of potassium citrate in the thickness of biodiesel when the diameter of the plate: 1 – 10 μm; 2 – 50 μm; 3 – 100 μm; 4 – 500 μm; 5 – 1000 μm; 6 – 1500 μm

Table 1

Indicators deposition plates aqueous solution of potassium citrate in biodiesel

Parameter	The diameter of the plate, microns		
	10	50	100
Re	$2,39 \cdot 10^{-13}$	$7,47 \cdot 10^{-10}$	$2,39 \cdot 10^{-8}$
v_{oc} , m/s	$3,125 \cdot 10^{-7}$	$7,82 \cdot 10^{-6}$	$3,125 \cdot 10^{-5}$
t_{oc}^* , days	37	1,48	0,37

* – the time of deposition of the records of an aqueous solution of potassium citrate in the thickness of biodiesel height 1 m

If the plate an aqueous solution of potassium citrate would've kept the size that they form by neutralizing biodiesel aqueous solution of citric acid (0,5 to 1,5 mm), the time of deposition in the thickness of biodiesel height of 1 m would take from 2 to 20 minutes. However, when neutralizing the formed plates are split with a

mechanical stirrer into smaller, time of deposition which increases substantially. If the time of deposition plates with a diameter of 100 μm is about 10 hr, then plates with a diameter of 50 μm are deposited within 1,5 days, and with a diameter of 10 μm is up to 40 days. The situation is complicated by the fact that there is a wide polydispersity of the particles of an aqueous solution of potassium citrate in the biodiesel after neutralization, resulting in incomplete cleaning of potassium hydroxide.

One of the ways to increase the efficiency of purification of biodiesel is washed with water by spraying it over the surface of the biodiesel with the subsequent movement of water droplets to the bottom of the tank. During the movement of liquid droplets connected with the plates of pollutants and capture them.

Dynamics of change of the deposition rate drops water over time in the absence of the initial velocity are shown in Fig. 2. As can be seen from the table 2, droplets with a diameter of 2 mm are deposited in laminar regime ($Re < 2$), by increasing the diameter of the drops of more than 2000 μm their deposition is carried out in a transitional mode.

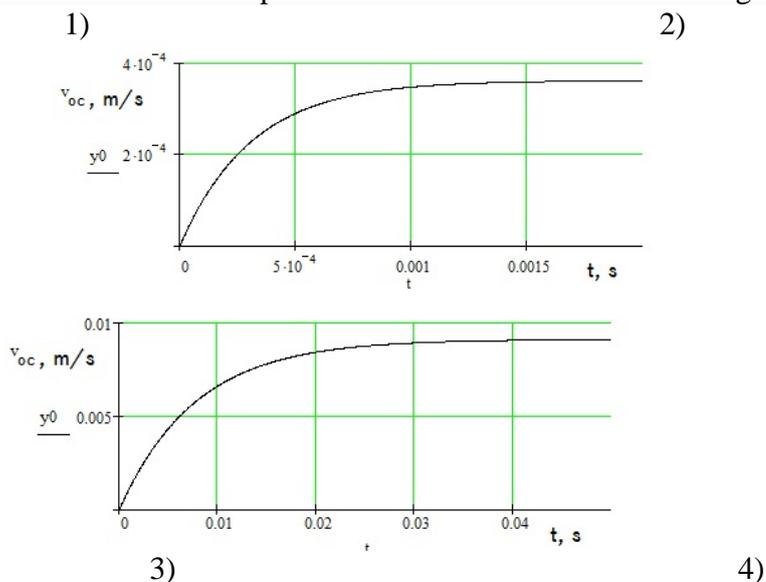
The mechanism of action of the forces of gravity, Archimedes and the resistance drop is similar to the action of these forces on the plate in a cylindrical shape.

Table 2

Indicators deposition of water droplets in the thickness of biodiesel

Parameter	The diameter of the plate, microns					
	100	500	1000	1500	2000	2500
Re	$3,2 \cdot 10^{-6}$	0,01	0,24	0,8	1,9	3,7
v_{oc} , m/s	$3,6 \cdot 10^{-4}$	$9,1 \cdot 10^{-3}$	0,031	0,047	0,062	0,078
t_{oc}^* , s	2778	110	32	21	16	12,8
min.	46,3	1,8	0,54	0,35	0,27	0,21

* – the time of deposition of water droplets in the thickness of biodiesel height 1 m



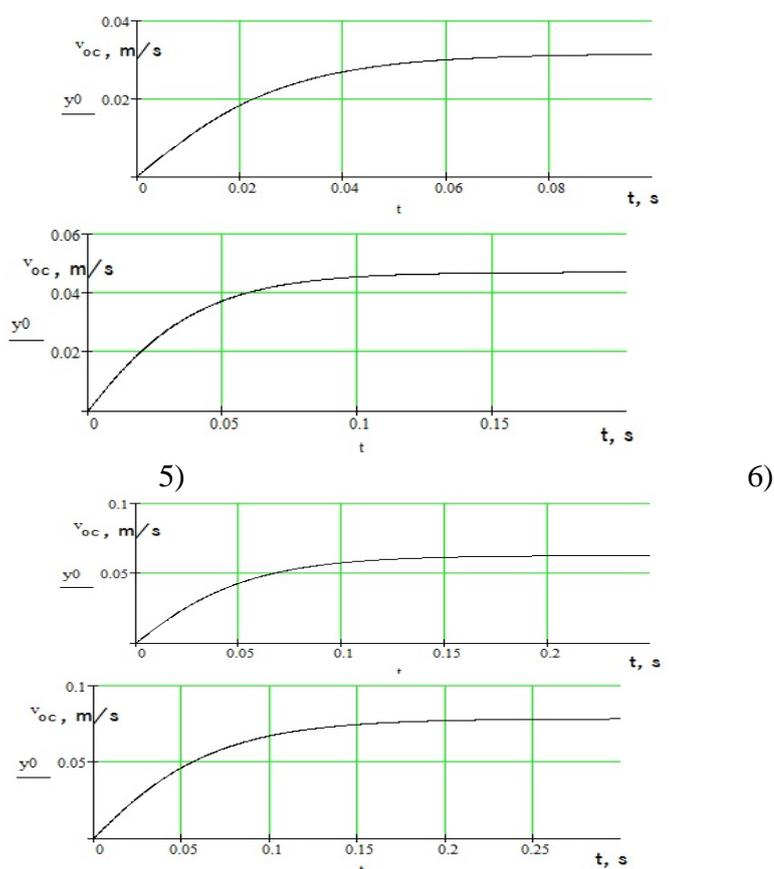


Fig. 2. The deposition rate in the thickness of biodiesel drops of water when their diameter: 1 - 100 μm ; 2 - 500 μm ; 3 - 1000 μm ; 4 - 1500 μm ; 5 to 2000 μm ; 6 - 2500 μm

Conclusions

1. The time of deposition of the records of an aqueous solution of potassium citrate when cleaning the biodiesel from the catalyst may be from 0,5 to 40 days. Therefore, to speed up this process, it is recommended to spray in the thickness of the biodiesel water droplets that attach to it self contaminant particles and transport them to the bottom of the reactor.

2. Since the diameter of water droplets 1 mm further increase their dispersion does not significantly affect the deposition rate. It is therefore desirable to wash the biodiesel by spraying drops of water in it with a diameter of 0,5 to 1 mm. The deposition rate of these drops do not exceed 2 minutes. Decreasing the dispersion drops their rate of deposition increases significantly.

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IMPROVING THE EFFICIENCY OF BIOGAS PRODUCTION BY USING WASTEWATER WINERIES

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Abstract: The methods of wastewater treatment plants wineries. Proposed to be used as a component of a substrate for biogas production. Investigated biogas production from substrate based wastewater wine production

Keywords: sewage wine production, biogas substrate cattle manure

Introduction. At the beginning of 2013 wine production in Ukraine amounted to 22,6 million dkl [1]. At 1 dkl L made wine is formed of 0,05 m³ of industrial wastewater, i.e. for the year wineries produce 1,13 million m³ of industrial wastewater containing contaminants in the form of stems, remnants of leaves, small particles of damaged fruit. In addition, in industrial effluents there are a large number of grape squeeze (from presses), and from washing the filter cloth in the waters remains a certain percentage of grape must. When tannin and gelatin improvement wort formed colloids containing protein in the form of sludge [2]. Therefore, industrial waste water wine production is a complex physico-chemical system, which, together with the dissolved substances contained particles of different degrees of dispersion, the size of which varies widely (from 0,001 micrometer to 10 mm). In addition to suspended solids, sewage wineries contain significant amounts of dissolved substances that can be removed only by chemical or biochemical by [3].

Therefore, industrial waste water wineries should be mandatory purification.

Analysis of recent research. Wastewater enterprises in wine industry are treated in a municipal wastewater treatment plants (wastewater urban wineries) and on their own wastewater treatment plants (sewage enterprises located in villages or rural areas) [2]. If large solid particles are separated from industrial wastewater by sedimentation (the sand trap and settling tanks or filter, the reduction of their size separation of the effluent into fractions is significantly complicated. For this purpose it is necessary to use, for example, flotation plants [3]. Physic-chemical methods of wastewater treatment include the use of coagulants in the form of lime and in combination with salts of iron or aluminum, the use of which allows to reduce the content of suspended particles by 70-80%.

Biological treatment of wastewater from wineries can be produced in vivo in the fields of filtration, irrigation, biological ponds drives, with the subsequent use of wastewater for irrigation, and in artificially created conditions on the filters, aeration tanks.

High-performance structures in wastewater treatment plants are biological ponds, which allow to reduce the rate BSC (the amount of oxygen consumed by aerobic biochemical oxidation under the action of microorganisms and the

decomposition of unstable organic compounds contained in the analyzed water, for 5 days) on 76-89%.

Aerobic wastewater treatment may take a very long time, and equipment to ensure occupies a large area. Another method of wastewater treatment is anaerobic, which in the digesters melanotic bacteria carry out wastewater treatment associated with production of biogas. Due to artificial heating is reduced cleaning time. However, low specific metabolic activity of methane biocenosis require intensive process wastewater availability inside the reactor to the high concentration of biomass that is not present in the wastewater wineries [4]. In addition, the low concentration of biomass results in a negligible yield of biogas, which significantly increases the cost of the cleanup process. Therefore, the process of anaerobic wastewater treatment wineries significantly complicated by the low concentration of biomass.

The **purpose of our research** is the definition of the use of wastewater wineries without purification.

Results. If close to wineries posted by farm or livestock complex, industrial waste water wineries can be used for dilution of the manure at the stage of preparation for methane fermentation. In this case, there is no need for treatment of wastewater before it is discharged into reservoirs, because educated bio sludge will be used as organic fertilizer.

The relative humidity of the substrate loaded into the digester W_G^2 , should be not less than 92% in summer. The relative humidity of cattle manure (a mixture of feces and urine) is 86-87%.

Therefore, to bring the cattle manure coming from the farm, to a condition suitable for methane fermentation, it is necessary to add water that is not less than 0,43 manure mass. Part of this water can be replaced industrial waste waters wine production.

We have carried out a study of the impact of wastewater wine production in the case of partial replacement of their water upon dilution of the manure to the biogas yield. The study was conducted at the biogas plant in teaching and research laboratory of bioconversion in agriculture National University of life and environmental sciences of Ukraine.

Methane fermentation was carried out under periodic loading of the substrate. Digester volume 29 m^3 was downloaded substrate half (the load factor is 0,5 in). When adding a new portion of the substrate reborn substrate is changed by half the coefficient of discharge is 0,5). That is, when a new load in the digester was added 7,5 kg of substrate. As the substrate was used cattle manure (solid fraction) collected in the pasture. When the relative humidity is 80% mass of water to dilute the manure 1,5 times the mass of manure. The digester is loaded 3 kg of manure diluted with 4,5 kg of water. During the research part of the water was replaced by sewage wine production, are given in table. 1.

Table 1
The composition of the substrate when studying the effect of wastewater wine production on the yield of biogas with a methane fermentation of cattle manure

Figure	Experience 1	Experience 2	Experience 3	Experience 4
The cattle manure, kg	3	3	3	3
Moisture, kg, of which:	4,5	4,5	4,5	4,5
Water, kg	4,5	4,35	4	3,5
Drains wine production, kg	0	0,15	0,5	1
'	0	3	11	22
%				

The research results shown in Fig. 1.

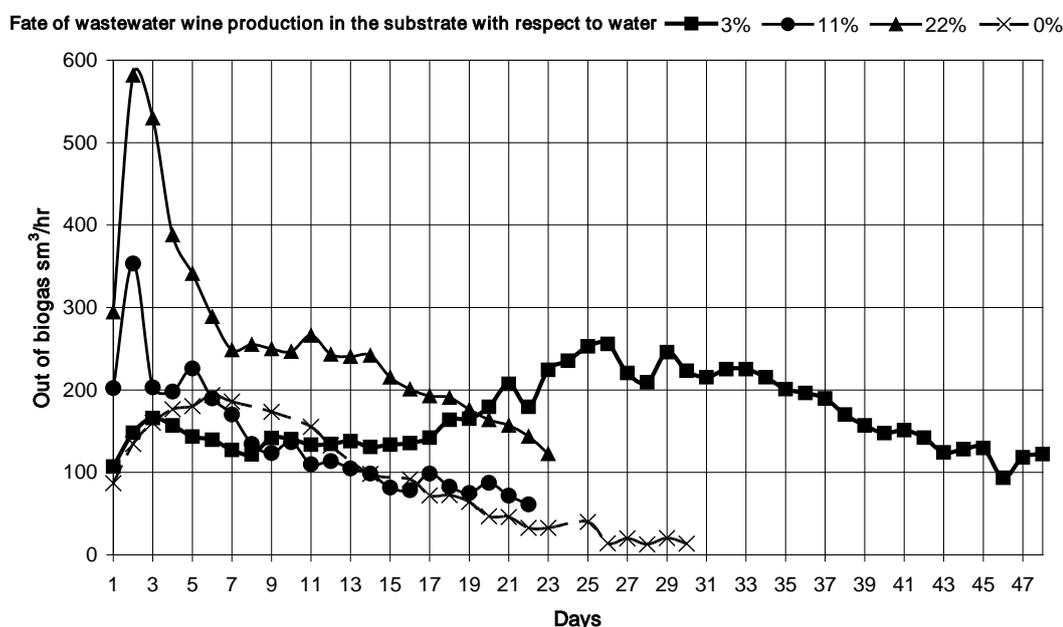


Fig. 1. The output of biogas with methane origin of cattle manure, depending on the share of wastewater wine production in relation to water in the substrate

As the research showed, in all cases, the use of effluent wine production was observed two maximum biogas yields that correspond to using two substrates. In this case, there are two maximum biogas yields. When the fermentation substrate, made with the addition of pure water, two maximum biogas yields not observed.

With 3% addition of effluent wine production to water in the preparation of the substrate the first peak of the biogas yield is observed on the third day of fermentation. The biogas yield is insignificant and amounts to little more than 150 cm³/h. After rather long privitannia bacteria to the second component of the substrate during the second experiencing phase accounts for 24-30 days of fermentation. At this time, the maximum biogas yield more than 250 cm³/h. After 30 days of fermentation begins dying colonies of bacteria as a result of the depletion of nutrients

and accumulation of waste products of anaerobic microorganisms, resulting in biogas yield gradually decreases. Complete the fermentation time is relatively long, the fermentation period can reach up to two months.

With increasing effluent concentration of wineries in the intensity of the first exponentially phase increases significantly, and the time is reduced. The maximum biogas yield when added to the substrate 11% wastewater wineries is 350 cm³/h, 22% of the approximately 600 cm³/h. Maximum biogas yield is observed on the second day of fermentation. Second exponential phase is expressed not so bright and when added to the substrate 11% wastewater wineries observed after 5 days of fermentation at 22% is on the 11th day.

Conclusions

1. Стічні води виноробних виробництв можна використовувати для часткової заміни води при приготуванні субстратів для виробництва біогазу.

2. Додавання стічних вод виноробних виробництв до води при приготуванні субстрату на основі гною ВРХ в кількості 11% дозволяє збільшити максимальний вихід біогазу в 1,5 разів, в кількості 22% - в 3 рази. Менший вміст стічних вод виноробних виробництв в субстраті суттєво не поліпшує вихід біогазу порівняно із використанням для приготування субстрату звичайної води.

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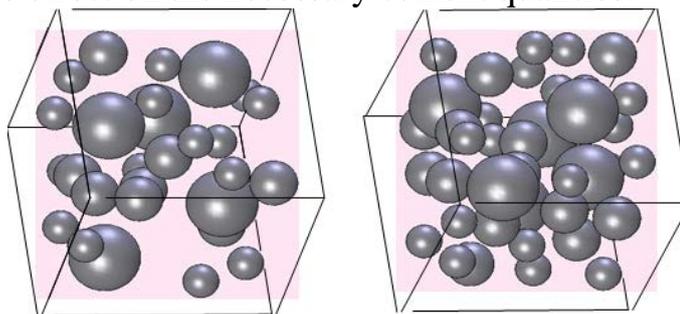
Poluektova V.A., Shapovalov N.A., Malinovker V.M.
INFLUENCE OF SUPERPLASTICIZER SB-FF ON
CEMENT BRICK COMPOSITION

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Abstract. In this paper we describe the influence of the superplasticizer SB-FF based on phloroglucinefurfural oligomers on the adaptation processes of cement and formation of the cement brick composition. It is shown that the delay in the plastic strength development of hydrated cement does not take place at an early stage subject to optimal doses of the additive.

Key words: superplasticizer, cement hydration, cement brick composition.

Nowadays the problems of strength improvement and durability of cement are successfully solved by means of its modification. The methods of modification can be different. The use of small amount of various chemical substances influencing on the cement hydration processes and formation of the cement block composition is one of the most available methods for mass concrete produced in large quantities. It gives the opportunity to have effect on the necessary cement qualities.



Pic 1. Influence of ratio water/cement on volume of intergranular space of cement dough: *a* – without superplasticizer, *b* – with superplasticizer

The appearance of superplasticizers and hyperplasticizers, a breakthrough in the cement science, made it possible to coin a new term “modified cement” [1]. Reducing the water content significantly while providing the equal consistency of concrete mixture they increase the concrete strength or make it possible to save cement. The models of cement particles distribution in the cement dough of equal consistency without additives and with the superplasticizer (pic. 1) show that the use of the superplasticizer considerably reduces the volume of intergranular space and, as a result, capillary porosity that is the determining factor for strength, cold-resisting quality and corrosion resistance of cement.

The aim of this work was to analyse the influence of SB-FF superplasticizer on the face composition and qualities of cement block. SB-FF is a surface-active modifying additive for highly concentrated phloroglucinefurfural oligomers-based mineral suspensions, synthesized in BSTU named after V.G. Shukhov. Previously the data on the adsorption of SB-FF oligomers on the surface of chalk, alumina and silica

particles from aqueous solutions was received [2]. It has been established that the irreversible monomolecular adsorption of SB-FF oligomers on the surface of chalk, alumina and silica particles takes place; at the same time the solid-solution interfacial tension declines [3]. It has been found that phloroglucinefurfural oligomers insertion leads to aggregates peptization and release of immobilized water [4]. Besides the value of yield point goes down to zero and the plastic stickness goes down to the lowest value [5].

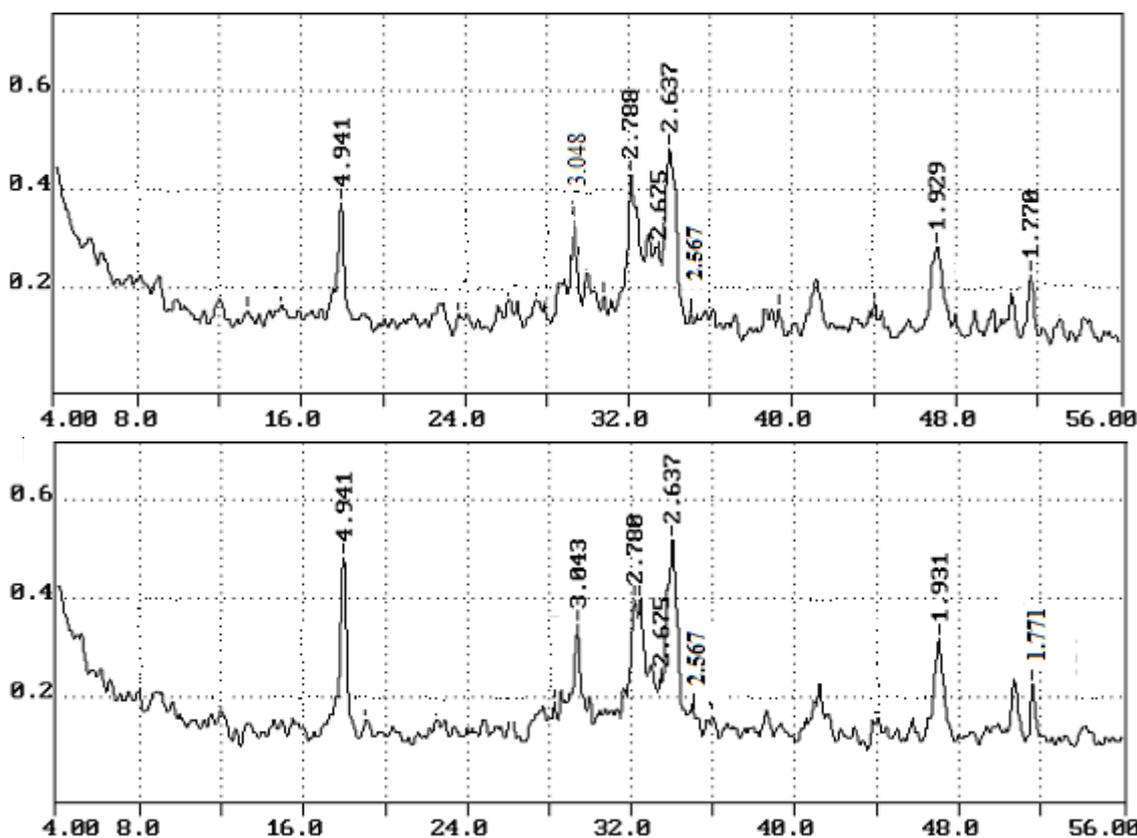
The research of the superplasticizer effect on the cement block composition was conducted with the help of X-ray phase analysis. The quantitative X-ray phase analysis, the main aim of which is to define the content of particular phases in multiphase polycrystalline materials, is based on the dependence of the diffraction maximums intensity (reflections) on the content of the phase being determined. The phase content being increased, the intensity of its reflections grows. However the dependence between the intensity and the content of the given phase is ambiguous for multiphase materials as the value of reflection intensity is determined not only by its content but also by the attenuation rate μ characterizing the attenuation degree of X-rays in passing through the given substance. The mentioned attenuation rate of the substance under investigation depends on the attenuation rates and the content of all the phases in its composition.

In accordance with the results of reflections intensity measurements calibration curves were plotted where the mass fraction of the corresponding mineral in the blank mix was plotted on the Y-axis and the intensity ratios of analytic mineral lines and etalon, fluorite, were on the X-axis. The quantitative phase analysis of some clinkers was carried out with the help of these curves.

Picture 2 shows the effect of synthesized SB-FF superplasticizer on the phase composition of cement brick, based on Oskol CEM I 42,5N. The research of the cement brick based on different types of cement without the additive (control sample) and with the additive SB-FF has been made. The cement brick was received from the mixes with the equal value of water-solid ratio. The curing conditions were identical.

By the 28th day there is much greater intensity of clinker material hydration in the specimens with the SB-FF superplasticizer in quantity 0,1%. It is proved by clear reflections of portlandite $\text{Ca}(\text{OH})_2$ (lines 4.94\AA and 2.63\AA), ettringite $3\text{CaO}\cdot\text{Al}_2\text{O}_3\cdot3\text{CaSO}_4\cdot32\text{H}_2\text{O}$ (line 2.56\AA) and hydrated sulfoferrite $3\text{CaO}\cdot\text{Fe}_2\text{O}_3\cdot3\text{CaSO}_4\cdot32\text{H}_2\text{O}$ (line 2.56\AA). If the additive concentration is further increased, the reflection intensity of $\text{Ca}(\text{OH})_2$ continually decreases. If there is 0,4% SB-FF in the cement brick, the reflection intensity equals to the value of the control specimen. Lines 3.04\AA and 2.78\AA characterizing alite C_3S and belite C_2S are shown less intensive than similar lines of the control specimen on the X-ray diffraction pattern of the cement with SB-FF. It testifies that the additive under study encourages hydration of these clinker minerals.

70-80% of the cement qualities are determined by the most important mineral alite that has similar to portlandite main characteristics (water requirement, bondability). Belite provides concrete curing from some months to several years. The most high-early-strength and fast-setting concrete is three-calcium alluminate. Four-calcium alluminate is similar to alite (water requirement, bondability, strength).



Pic.2. Effect of superplasticizers on cement brick phase transition at Oskolcement CEM I 42,5N: a) control; b) with 0,1% SB-FF

The research results of the additive effect on the cement setting time with the equal value of water-cement ratio are presented in Table 1.

**Table 1
SB-FF effect on setting time of cement suspensions**

Cement type	Additive ration, %	Settinh time, h. min.	
		Beginning	End
Belgorod CEM I 42,5N	-	1 h. 03 min.	4 h. 35 min
	0,1	2 h.	6 h. 45 min.
	0,2	7 h.	11 ч.
Novorosiisk CEM I 42,5N	-	1h. 15 min	2 h. 10 min.
	0,2	2 h. 05 min.	8 h. 55 min.
Oskol CEM I 42,5N	-	3 h. 20 min.	5 h. 10 min.
	0,2	4 h. 10 min.	7 h. 10 min.

The effect of cement setting retardation under optimal doses may be used while transporting cement mixes long-distance when it is necessary to save their fluidity. The cement block produced from fluid cement mixes does not loose its strength in 7 and 28 days in comparison with control specimens. Adding 0,10% SB-FF of cement mass into the cement suspension increases suspension fluidity up to 70% of maximum and strength growth of cement block up to 15% in comparison to control

specimens.

Optimum content of SB-FF in cement mixes of equal fluidity makes it possible to reduce the amount of mixing water by 30% and more while the strength growth of cement block increases by more than 25 MPa.

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INFLUENCE OF RIGID LUBRICATIONS TO MAIN PERFORMANCES DISCONTINUOUS CUTTING

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Abstract: If there is solid lubrication of basic performances of process of cutting (length of a contact, angle of displacement, temperature and forces of cutting) it is sharply changing at the moment of indenting, then up to the end of operation of solid lubrication is stabilized. After that, there is their gradual approximation to the characteristics of intermittent cutting (without lubrication) and steady cutting in simulated condition.

Keywords: contact interaction, plastic deformation, rigid lubrications, discontinuous cutting.

The features of contact interaction and plastic deformation in a zone shaving deformation first of all exhibit themselves in modifications of main performances of discontinuous cutting, such as length of contact, angle of a shift and shrinkage of a shaving, and also force of cutting. For a possibility of a comparison researches of main performances with application and without application of rigid lubrication in parallel were conducted. In a number of cases the outcomes were compared with placed (installed) continuous steady cutting in the same conditions of processing.

The research of contact interaction with use of rigid lubrications was conducted in main for two kinds of lubrications - fluoride of calcium CaF_2 and fluoride of barium BaF_2 . It is connected that the data's of lubrication have shown the best outcomes for want of the research of a tool on a stability tests.

With the help of adaptations ensuring a constant a thickness of a sheared of a stratum for want of discontinuous cutting [1] and using bar with various length of a machine cut, the dependence of length of contact on length of a machine cut (fig. 1) was obtained. In both cases (with lubrication and without lubrication) length of contact not constant and especially sharply will increase in an initial moment

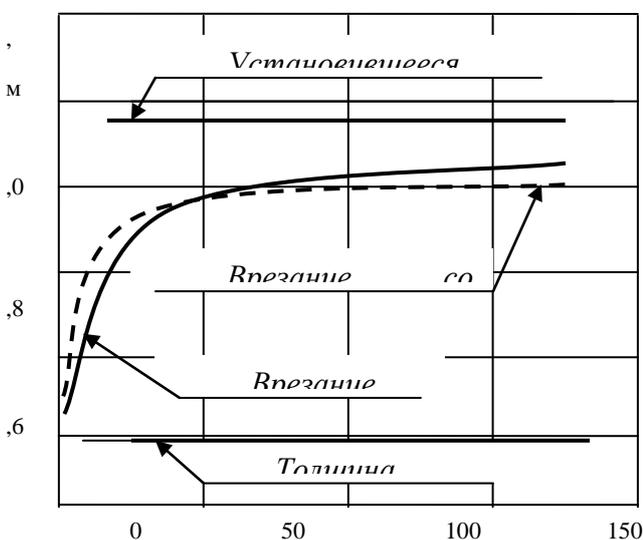


Fig. 1 Of length of contact on length of a machine cut

indenting. However, if without lubrication the growth of contact being decelerated proceeds, coming nearer that has a place for want of placed (installed) cutting, with lubrication after sharp magnification it the magnitude is stabilized without noticeable increase. For want of it she (it) all time is less than length of contact for want of cutting without lubrication. It is necessary to mark, that the use of lubrication renders influence and on the form of a shaving. The shaving obtained for want of

discontinuous cutting generally has large curvature, especially brightly exhibited in initial period *врезания* (the radius of a curvature is minimum). In case of lubrication curvature of a shaving noticeably it is less. This is not contradicted also by (with) a character of a modification of length of contact in a fig. 1, when in an initial moment length of contact with the greater velocity will increase for want of cutting with lubrication. The given phenomenon is connected with more heavily (intensive) curvature of a shaving in a vertical plane for want of cutting without lubrication. Such heavily (intensive) curvature promotes a separation of a shaving from a forward surface and constrains growth of length of contact [1]. In case of application of lubrication smaller curvature it is possible to explain by absence of a contact zone on a forward surface and smaller gradient of temperatures on a surface of a shaving with the party of a cutter and above a cutter. Such explanation coincides the judgement expressed in work [2], that curvature of a shaving in a vertical plane is connected to nonuniformity of a strain on height of a shaving. Therefore stability of contact interaction in period indenting (the external friction with elements adhesive of grasping) reduces nonuniformity of a strain on height of a shaving, accordingly reducing curvature (curling) of a shaving in a vertical plane and by that increasing growth rate of length of contact. And as the character of contact interaction at the presence of rigid lubrication does not vary, after reaching the certain magnitude, length of contact for want of consequent cutting will increase insignificantly. However, if for want of to large length of a machine cut, in any instant the lubrication disappears and the contact plastic deformation begins, it again results in magnification of length of contact and consequent monotone it to growth.

One from main performances of process of cutting is the magnitude of an angle of a shift, defining work expended for plastic deformation in a zone shavingformation.

In the correspondence with submissions [2], the shaping of an angle of a shift is determined by the attitude (relation)) average integrated of significances of a resistance to plastic deformation on a part of a plot (site) of plastic contact (plot (site) of hardening (strengthening)) to a resistance of a shift in a zone shavingformation τ_{kai}/τ_{cai} . Physically sense of influence τ_{kai}/τ_{cai} on an angle of a shift (β) consists that this attitude (relation) reflects correlation of processes which are flowing past in two zones of plastic deformation. For want of it the direction of lines of maximum tangents of voltages in a zone shavingformation will differ from maximum significance the more, than higher is the resistance to deformation in a contact zone. Thus, the magnitude of an angle of a shift depends on maximum significances and regularities of a modification of tangents of voltages on a breadth of a zone shavingformation and length of a plot (site) of plastic contact.

Measurement of an angle of a shift (β) the zones, conducted on the initial boundary, shavingformation on microslices of the radicals of shavings obtained in various moment from a beginning of indenting, have allowed to construct dependence of a modification of an angle of a shift on length of machine cut both for cutting without lubrication, and with lubrication. From the represented schedule (fig. 2) it is visible, that the character of a modification of an angle of a shift repeats a character of a modification of length of contact - in the first instants the ambassador indenting an angle of a shift sharply decreases, then smoothly comes nearer to significance of an angle of a shift for want of placed(installed) cutting in the same conditions. And, as well as for length of contact, the character of a modification of an angle of a shift for want of application of lubrication differs a little. In an initial moment of indenting it(he) also decreases, but as the contact plastic deformation is blocked by rigid lubrication, this diminution is less much(less significant). After reaching the certain magnitude for want of consequent cutting, continuing insignificantly to decrease, the magnitude of an angle of a shift is stabilized remaining all time more, than without lubrication. However, in the event that the

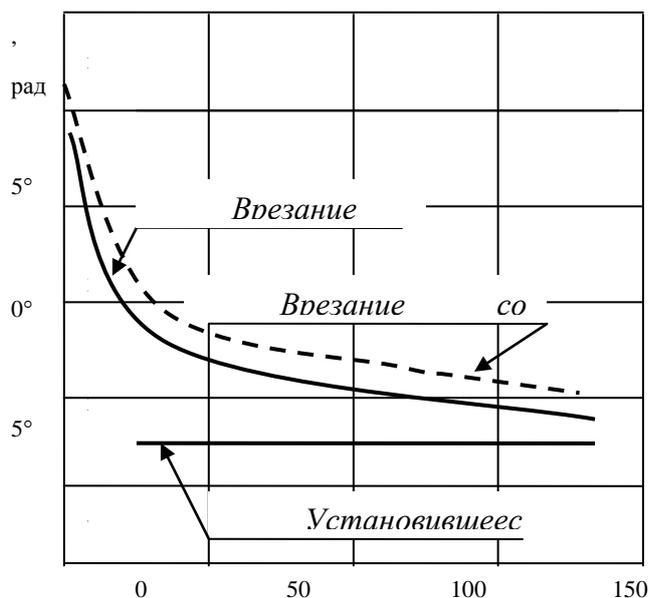


Fig. 2 Of length of an angle of a shift on length of machine cut

operation of lubrication ceases and the zone of contact strains (such is formed there are for want of to length of a machine cut $\sim 100\text{mm}$), the diminution of magnitude of an angle of a shift (fig. 2) is again observed.

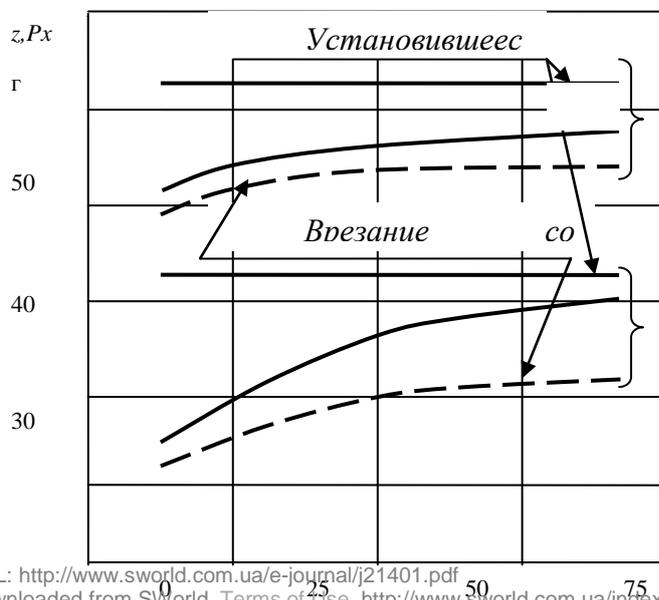
The conducted researches and analysis of a level of microhardness achieved in a zone shavingformation and in a contact zone, show, that the parity(ratio) τ_{kai}/τ_{cai} in the beginning and in an extremity peza (cutting with lubrication) varies insignificantly and then, when the lubrication acts up to an extremity and then, when it the operation is finished up to a moment of an output(exit). However, despite of a constancy of the attitude(relation) of tangents of voltages in a contact zone and zone shavingformation, on length of machine cut for want of cutting both with lubrication and without it(her) happens continuous modifications of an angle of a shift, that contradicts sights [2]. Therefore, the author of the present researches agree with conclusions, that is necessary to refuse the judgement, what exactly the parity(ratio) average integrated of magnitudes of tangents of voltages determines magnitude of an angle of a shift. It is necessary to consider(count), that the defining influence to magnitude of an angle of a shift renders the attitude(relation) of the integrated sums of tangents of voltages on plastic contact and in a zone shavingformation $\Sigma\tau_k/\Sigma\tau_c$. In other words, it is necessary to return to the judgement Zorev N.N. [3], that the position of a conditional plane of a

shift is determined by the attitude (relation) of tangents of forces acting on a forward surface and in a zone shaving formation.

Simultaneously with an angle (β) other is changed performance, rigidly connected with him the characteristic of process of cutting. Namely shrinkage of a shaving. For cutting with lubrication the magnitude of shrinkage always is less than that of a parameter for want of cutting without lubrication. For want of it the character repeats it of a modification a character of a modification of length of contact.

The analysis of magnitude and character of a modification (changes) of shrinkage of a shaving allow to assume, that the magnitude of a component force of cutting with application of lubrication is less, than in it the absence and is significant it is less, than in similar conditions for want of steady cutting. This conclusion refutes data's in the correspondence with which component forces of cutting for want of milling always on 10...20% are more, than for want of steady cutting.

The large magnitudes of component forces of cutting for want of milling, rather than for want of steady cutting, are explained by the authors to that because of kinematic conditions and conditions, implying from them, of friction the shrinkage of a shaving for want of face milling it is more than for want of steady cutting, the angle of a shift is less, and the square of a plane of a shift for want of identical conditions of cutting accordingly is more, than for want of steady cutting. However, as show outcomes of experiments on a comparison of main performances of placed (installed) cutting and discontinuous cutting with lubrication and without, and also their consequent analysis, force of cutting for want of to discontinuous processing, especially for want of use of lubrication, is much lower. For acknowledgement (confirmation) can be direct measurements tangential and axial (P_z and P_x) component forces of cutting for want of discontinuous cutting with lubrication or without in a comparison with placed (installed) by cutting in the same conditions (fig. 3). For convergence of outcomes of a force were compared for want of cutting same hard-alloy is acute, grinded, by a slice without a bevel and without a radius for want of to top, with the help of a dynamometer and were fixed by the oscillograph. From represented data's it is well visible, that on a measure of a



indenting force continuously grow, not reaching (achieving), however, magnitude of forces for want of placed (installed) cutting. For want of it, for cutting without lubrication in the greater degree the force P_x and in smaller P_z grows. With application of lubrication the picture varies on opposite with one only by difference – P_x practically will not increase. The saltus of forces is fixed only after vanishing from contact of lubrication in an extremity of a machine cut. In this

moment more heavily begins to grow a tangent a force P_x .

The differences in forces of cutting exhibited for want of way and counter milling are explained by various magnitude of contact surfaces between a shaving and tool. It is possible to agree with it and for want of comparison of discontinuous and placed(installed) cutting (the difference in square of contact makes about 50%. Whereas for counter and way -10...20%). However, obviously, that in case of rigid lubrications the difference in forces is connected not only to distinction (difference) in length of contact, but also and with a different character of contact interaction on a forward surface. It is possible to consider(count), that the contact interaction with lubrication is similar to contact interaction for want of placed(installed) cutting with a velocity below than transitional velocity V_T [2], when also has a place external friction.

As to dynamics (changes) of a modification of forces of cutting depending on a velocity, for want of cutting with lubrication she(it) is close to that has a place for want of usual discontinuous cutting. With growth of a velocity of a force drop, however, in some smaller degree, than without lubrication, when this falling, is connected to a diminution of tangents of voltages in a zone of contact plastic deformations.

Conclusion

1. For want of application of lubrication length of contact as a rule is less a little, than in it the absence and is changed on main length (within the limits of an operation of lubrication) a little. After vanishing lubrication she(it) begins to be increased, coming nearer to discontinuous cutting without lubrication and to placed(installed) cutting.

2. The angle of a shift, as well as length of contact, after a sharp diminution in a moment of indenting is stabilized on main length of cutting. After cancellation of lubrication a noticeable diminution and approximation to an angle of a shift for want of placed(installed) continuous cutting again begins it.

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Piganov M.N., Tyulevin S.V., Mishanov R.O.
ANALYSIS OF THE UNRELIABILITY REASONS AND THE
DIAGNOSTIC NON-DESTRUCTIVE TESTING INSTALLATION FOR THE
INTEGRATED STABILIZERS

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The article is devoted to a choice of the informative parameters for the NDT of the integrated stabilizers. The selection results of the integrated stabilizers sample using one and two criteria are stated. Special attention is paid to the schematic diagram and the operation principle of the diagnostic NDT installation for the integrated stabilizers.

Key words: Non-destructive testing, informative parameter, integrated stabilizers, microcircuit, supply voltage, selection, installation, reliability, classification.

Introduction. In modern devices a wide range of active and passive discrete electronic components, hybrid and semiconductor integrated circuits (IC's), micro assemblies, functional electronic devices and other items are used. Due to the complication of the functions which are carried out by the equipment also its complexity which is estimated by number of the elements entering it grows. This can be clearly seen in the case of the equipment used in space vehicles (SV). Increasing complexity of the electronic equipment dramatically increases the reliability requirements of the components. Severe operating conditions of the equipment on the spacecraft board are aiming to select the most reliable elements.

Selection of premium quality electronic radio components (ERC) is usually carried out by the methods of electro diagnosis or diagnostic non-destructive testing (NDT). They are based on the principle of identifying the electrophysical parameters (informative parameters) characterizing the state of ERC, and the definition of life electrical radio on selected criteria by comparing the measured informative parameters with their thresholds. In this case, ERC that are related to potentially unreliable are rejected. Their main characteristics are agreed with the technical requirements. However, the ERC have hidden defects that may eventually lead to the failure.

Review of the literature. At this stage, the various methods and tools for NDT element base, which is used in the responsible equipment, have developed [1-7]. However, growth in the range of constantly going ERC various functions and the use of new materials, structures and manufacturing processes require new informative parameters, more precise criteria for rejection, the development of new means of control. This issue has a particular importance in relation to the creation of the spacecraft, which has a long active functioning. More stringent requirements for the reliability, accuracy and efficiency of NDT increase the complexity of the automation of diagnostic tools and rejection. Therefore, with the development of such funds it is necessary to take additional measures to improve the reliability of their operation.

The greatest difficulty is the diagnostic monitoring of semiconductor integrated circuits.

The main criterion at a choice of informative parameters for NDT of the IC is existence of their correlation communication with the reliability of controlled products, i.e. sensitivity concerning the defects and spatial not uniformity of physical properties of the last. For the microcircuit stabilizer 142EN5 with the fixed value of tension owing to the circuit inaccessibility of p-n junction of application of widely widespread methods m-characteristics, VAC and their derivatives, electro fluctuation diagnostics, etc. connected with considerable difficulties.

The input data and methods. Proceeding from requirements of the simplicity, efficiency and possibility of NDT combination with parametrical control, possibility of use as informative parameters - the parameters U_{out} , K_u , K_i , I_{con} . were considered.

In the analysis in the previous section of the unreliability reasons and elements of the microcircuit 142EN5 communication of the majority of bipolar structure defects with change of currents through p-n junctions is noted.

Really, passing of carriers of a charge in real p-n junction is defined by properties of volume and a surface of the semiconductor.

The total current through the junction consists of the following components:

$$I = I_1 + I_2 + I_3 + I_4,$$

where I_1 - volume generation-recombination (diffusive) current;

I_2 - generation-recombination current on OPZ surface;

I_3 - generation-recombination current in OPZ;

I_4 - current of superficial channels.

As the generation and recombination of carriers of a charge depend on concentration of the capacity and superficial defects, it determines the size of a total current through the junction.

On the other hand the size of current consumption I_{con} of the integrated stabilizer 142EN5 is defined by the currents of the corresponding p-n junctions, and also the quality of contacts and temperature condition in turn depending on quality of landing of a crystal in the case and thus can be used as informative parameter at microcircuit NDT.

Taking into account the carried out analysis, pilot studies including measurement of the parameters (I_{con} , U_{out} , K_u , K_{st}) and results of the tests for non-failure operation in the conditions of the increased and lowered temperatures, and also influence of the thermocycles which are carried out at the previous work stages as informative parameter offered the size of power failure of U_r proportional to the current of consumption of I_{con} on the model R_o resistor which is switched on in a power-supply circuit of a controlled chip.

For the selection of the integrated stabilizers of the increased reliability measurements of U_r in two tests are taken, respectively at minimum and maximum admissible supply voltages $U_{en min}$, $U_{en max}$.

By the results of the U_r parameter measurements for the training selection of the microcircuit 142EN5 classification of their potential reliability by the technological predefinition criterion according to which values of parameters of products at stable technological process lie in technologically predetermined area is carried out:

$$M [U_r] - S_i [U_r] < U_{rki} < M_i [U_r] + S_i [U_r],$$

where U_{rki} - value of the U_r the k -th microcircuit parameter in i -th dough ($i = 1,2$); M_i, S_i - a population mean and an average square deviation of the U_r parameter in a selection at realization of i -th dough.

Thus copies of the microcircuits which values of the U_r parameter don't get to the established borders of a critical zone of the U_r parameters ($U_{en\ min}$), ($U_{en\ max}$) distributions were expelled from party. Thus, the necessary but insufficient condition of the microcircuit selection on the level of potential reliability is carried out. The condition of sufficiency is satisfied at the additional grading of the chip which passed the first step of the selection by the regularity criterion of parameters dependence on the test modes for all products of selection (party):

$$| U_{rk1} - U_{rk2} | \leq 2\Delta U_{cu} + | M_1 [U_r] - M_2 [U_r] | ,$$

where U_{rk1}, U_{rk2} - values of the U_r of the k -th IC parameter respectively in 1 and 2 tests; $M_1 (U_r), M_2 (U_r)$ - population means of the U_r parameter in selection at implementation of 1 and 2 tests; ΔU_{cu} - voltmeter error.

At the second step of the selection from the products, potentially reliable by the first criterion, carried to a class copies which size U_r changed from the first dough ($U_{en\ max}$) to the second dough ($U_{en\ min}$) in relation to change of population means $| M [U_r] - M [U_r] |$ at a size, big the doubled voltmeter error were removed.

The results. Discussion and analysis.

The estimates of the NDT microcircuits 142EN5 reliability received for the selection by $N = 50$ components by grading of products on potentially reliable and potentially unreliable, respectively by one and two criteria with the subsequent tests for the non-failure operation in the accelerated mode are given in table 1 ($t = 2500$ h, $T = 80$ °C, $I_{con} = 150$ mA), where R_c - probability of the correct decisions, R_{sup} - risk of the supplier, R_{con} - risk of the consumer.

The tested integrated stabilizer is connected to the installation via the adapter A according to a pin-connection diagram. The external universal voltmeter B7-38 is connected to the nests "the voltmeter (+)", "the voltmeter (-)" (Figure 1, a).

Table 1

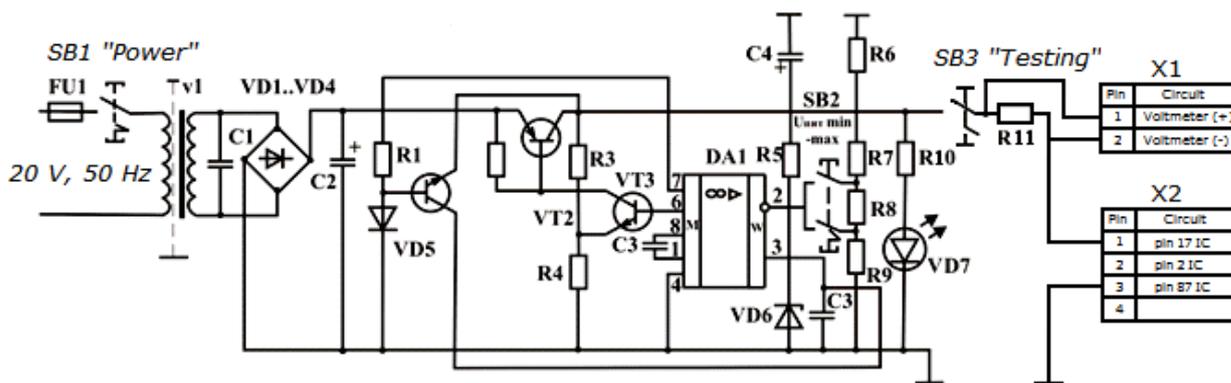
Estimates of reliability of the NDT of the microcircuits 142EN5

Quantity and number of criteria	Reliability assessment		
	Probability of the correct decisions, P_c	Risk of the supplier, P_{sup}	Risk of the consumer, P_{con}
1	0,88	0,06	0,18
1 и 2	0,94	0,12	0,08

At the wrung-out SB2 button pressing of the SB3 "control" button takes measurement of the U_r parameter at $U_{pow\ max}$ by reading of indications of the PV voltmeter. Then procedure repeats at the pressed SB2 button, i.e. at $U_{pow\ min}$.

The schematic diagram of installation is submitted in Figure 1.

Figure 1



The main functional knot of the scheme is the power supply including two-half-period rectifier (VT1, VD1,..., VD4) and a voltage stabilizer of compensation type (VT1, VT2, VT3, DA1). The demanded tension at the exit is established by the SB2 switch.

The indicator of existence of tension at the exit of the stabilized power supply is the light-emitting diode VD7 which lights up in the presence at the exit of tension, stabilized the power supply sufficient for its ignition. Basic tension is created by the stabilitron VD6 and moves on an entrance of 3 chips where there is its comparison with tension arriving on an entrance of 2 chips from R8 potentiometer. Thus R7 and R9 resistors serve for restriction of range of adjustment of tension. The comparison signal from a chip arrives on an entrance of the amplifier transistorized by VT2, VT3 which, in turn, and make adjustment of output tension. R3 and R4 resistors create shift, necessary for VT3. On the VT1 transistor protection against short circuit at the exit is executed when carrying out tests. At short circuit its emitter is connected through the small resistance of R11 to the cathode of the VD5 diode and at this VT1 opens, short-circuiting a basic stabilitron of VD6. From DA1 exit through VT3 in this case the locking tension on the regulating VT2 transistor which limits short circuit current to a minimum arrives. Thus the light-emitting diode of VD7 dies away. At elimination of short circuit the VT1 transistor is closed, stopping shunting of the basic VD6 diode. Thus from an exit of the amplifier of an error of DA1 through VT3 the unlocking tension arrives on base of the regulating VT2 transistor, restoring the set size of output tension of the stabilizer. The R10 resistor limits the current flowing through VD7 light-emitting diode. The R6 resistor provides an operating mode of the regulating VT2 transistor idling. Capacities of C2, C4 serve for smoothing of a pulsation of output tension. Purpose of capacity of C5 - decrease in noise of a stabilitron of VD6. The measuring chain includes the model R11 resistor and the X1 adapter for connection of conclusions of 8, 17 chips to a stabilizer exit, and also nests for connection of the external X2 voltmeter. Giving of tension on the controlling IC is exercised by pressing of the SB3 "control" button.

Analysis and reasons for the low reliability of integrated voltage regulators were given. Informative parameters to assess the reliability of stabilizers were presented.

Criteria for the classification of chips were recommended. The scheme for diagnostic non-destructive testing was offered. Results of reliability of the chips were

given.

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MATHEMATICAL MODELING OF USER BEHAVIOR AS A METHOD TO REDUCE VULNERABILITY OF INFORMATION SYSTEMS

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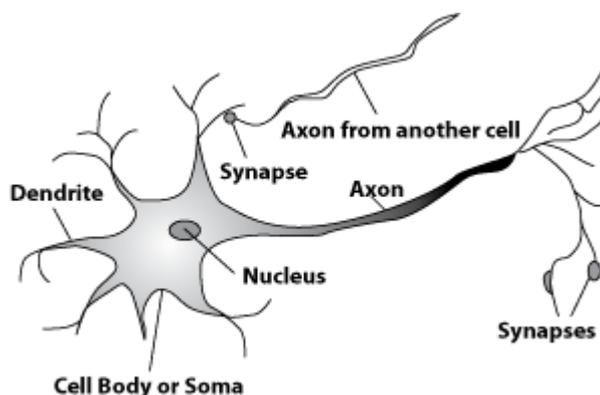
Abstract. In this paper, we consider the simulation of user behavior based on the statistics of a session usage of an information system. Suggested an approach that allows to increase the security of information systems by including user behavior module into the information system. Given a mathematical model for the simulation of user behavior and detect deviations from this model.

Keywords: modelling of behaviour, neural network, information security, information systems.

Introduction. Every year, more and more companies are switching to automated information. Automation of production processes brings a number of advantages, but also introduces a number of vulnerabilities could lead to information disclosure. The main users are vulnerable ACS, as well as the functionality to access information to the system based on the user's identity.

Review of the literature. The problem of machine simulation of human thought inspires scientists for centuries. More than 50 years ago created first electronic model of the nerve cells. In addition, there is a lot of work on the new mathematical models and learning algorithms, such as authors such as Racehorse SV, Kussul NN, Kalan, R., S. Haykin, S. Osovsky, Tarhov DA, Rutkovskaya D., L. Rutkowski, M. Pilinsky and many others. Today, so-called neural networks are of most interest in this area. They use a multitude of simple processing elements called neurons, each of which simulates the behavior of individual cells of the human brain.

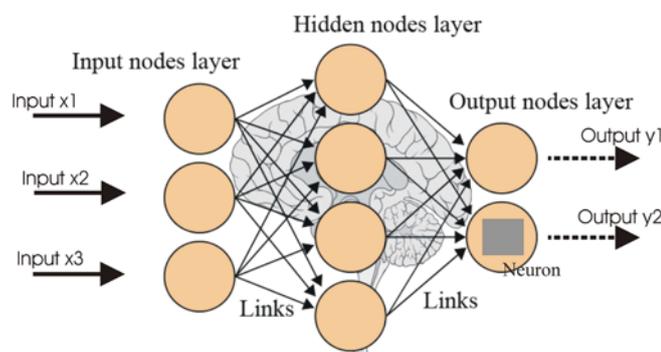
Input data and methods. Each neuron of biological neural network (pic.1) consists of a cell body, which contains the core. Branches off from the cell body a lot of short fibers called dendrites. Long dendrites called axons. Axons are stretched over long distances much greater than what is shown on the scale of this figure. Typically, the axons are 1 cm long (exceeding 100 times the diameter of the cell body), but can be as high as 1 meter.



Pic. 1. Biological neural network.

Each neuron in the neural network performs the conversion of input signals into

an output signal and connected with other neurons. Input neurons form a so-called neural network interface. The neural network (pic.2) has a layer that receives input signals, and a layer that generates output signals. Information put into the neural network through the input layer. All layers of the neural network to process the signals until they reach the output layer.



Pic. 2. The basic structure of the neural network.

The problem of neural network - the transformation of information as required. To this end, a network of pre-trained. When training use ideal (reference) value pairs "input-output" or "teacher", which evaluates the behavior of a neural network. To train a so-called learning algorithm. Untuned neural network is not capable of displaying the desired behavior. Learning algorithm modifies the individual neural networks and weight of its links so that the behavior of the network corresponds to the desired behavior.

There are many ways of constructing neural networks. They differ in their architecture and teaching methods.

The first step in designing a neural network is training its desired behavior. This - the phase of training. For this purpose, the so-called training set or a teacher. Master - is a mathematical function, or the person who assesses the quality of the behavior of the neural network. Since neural networks are mainly used in demanding applications where there is no good mathematical models, the training is performed using the training sample, that is, pairs of reference "input-output".

After training, the neural network is ready for use. This - the working phase. The result of training the neural network is to compute the output signals are close to the reference data at the respective input signals. At intermediate input signals network approximates the desired output value. The behavior of the neural network is determined in the operating phase, that is, for each combination of input signals are always output the same signals. During the current phase of the neural network is trained. It is very important for most technical applications, because the system will not seek to extreme behavior.

The essence of the application of mathematical modeling user behavior in security systems is to identify deviations from the behavior of the user previously defined models and future response of the system in accordance with a predetermined algorithm to block potentially dangerous for the system users.

Integrated user model takes into account both the dynamic (interactive part) and

statistics (part of a session), the properties of user behavior. Based on this model should be developed to take into account changes in user behavior - in other words, learn to recognize the user to simulate its behavior.

The basis of the developed model is put forward propagation neural network, which consists of an input, output, and one or more hidden layers of neurons. Output of a neuron in a layer of n is defined as (1) the ratio of:

$$y_j^n = f(s_j^n), \tag{1}$$

where n – is the number of layer ($n \in [1, p]$); p – the number of layers in the neural network; j – index of the neuron ($j \in [1, N_n]$); N_n – the number of neurons in layer; f – activation function layer (in our case for the hidden layers using a sigmoidal activation function (2), and for the output layer – linear (3));

$$f(x) = \frac{1}{1+e^{-ax}}, \tag{2}$$

$$f(x) = ax, \tag{3}$$

y_j^n – j -th output neuron layer; s_j^n – postsynaptic potential j -th neuron layer, which is calculated according to the following (4) formulas:

$$s_j^n = \sum_{k=1}^{N_{n-1}} W_{jk}^n * y_k^{n-1} + b_j^n; \tag{4}$$

$$S^n = W^n * v^{n-1}, \tag{5}$$

where W_{jk}^n – weighting coefficient of the connection k -th neuron of the layer n ; y_k^{n-1} – exit of the k -th neuron of the layer $n - 1$; v^{n-1} – advanced vector based on bias-neuron; b_j^n – threshold (bias-neuron's) of the j -th neuron of the layer n . Input and output of the neural network are determined, respectively, by the following (6) dependencies:

$$X = (x_1, x_2, \dots, x_{N_1}) \equiv (y_1^1, y_2^1, \dots, y_{N_1}^1). \tag{6}$$

Interactive model uses to detect abnormal activity during user. For each user, the computer system is constructed and trained neural network to predict the next command based on the previous ones.

The results of the neural network at time t determined by a dependence (7)

$$Y_t = F(X_t), X_t = (c_{t-1}, \dots, x_{t-m}), \tag{7}$$

Where F – nonlinear transformations of the neural network according to the formulas 1, 4, 5, 6, 7; c_t – t -th command of session; m – the number of commands which occur based on the following prediction (prediction depth).

The Results. Discussion and Analysis. Based on the number of teams that were correctly predicted by the neural network, it is concluded whether the current user behavior previously constructed model. It should be borne in mind that users tend to change behavior over time. Therefore, in order to provide their adaptation to the behavior of a neural network periodically re-train.

The output of the neural network can take two values: 1 - normal behavior for users and 0 - for anomalous. If the output of the neural network system receives 0, the system is able to recognize anomalous user behavior and apply the necessary measures to block the user working with the system.

Summary and Conclusions. The paper presents a mathematical model for

determining user information system based on a sessional user statistics of an information system. This mathematical tool for solving this problem uses a neural network of direct distribution to the input, which receives data on user activity during the session, and the output goes to the outcome of the compliance of the claimed user behavior normal behavior of the user. The use of mathematical apparatus described in the appropriate information systems with high security requirements, and systems are often subject to hacker attacks, or having weak mechanisms for the protection of information.

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J11510-034

Lysenko O.D., Lysenko D.I.

MONITORING OF SAFE TRANSFER OF THE INFORMATION*Poltava National Technical University named after of Yuri Kondratyuk*

Abstract. In of this paper we describe the use of problem question of the general access to the information ad its protection which provides information protection of the state. Development of communication technologies will cause increases in number of units of the networks scattered on all of the world, and quantity of different communication lines between them, that, in turn, raises risk of the non - authorized connection to a network for access to the important information. The of purpose of monitoring modern condition protection to computer networks, a direction of development of safe technologies. The of theme is actual for a modern condition of information space in of Ukraine. The of computer criminality will penetrate into all spheres of the state, therefore the information environment demands a maximum level protection.

Key of words: levels of protection, risks of information leakage, protocols of technology a client - server

Introduction. Potential of society is mainly determined by the volume of informative resources and level of development of informative infrastructure. Information constantly becomes complicated, changes quality, the amount of her sources and consumers grows. At the same time vulnerability of modern informative society grows from unreliable information, industrial espionage, and computer criminality. Therefore Constitution of Ukraine of providing of informative safety attributes the states to the major functions.

Development of communication technologies allows to build the networks of the up-diffused architecture, that unite plenty of the segments located on considerable distance one from other. All of it causes the increase of number of sites of networks sparse all over the world and amounts of different flow lines between them that in turn, promotes the risk of the unauthorized connecting to the network for access to important information. In this case the special tools of authentication of users are needed in networks that provide access to information only in case of complete confidence in a presence for the user of permissions to it.

Complication of creation of the system of priv is determined by that data can be stolen from a computer and at the same time to remain in place; the value of some data consists in possession by them, but not in elimination or change.

Growing popularity of local networks requires a corresponding priv, but historically they were projected not for differentiation, but for the facilitation of access and collective use of resources. In the environment of local networks within the limits of house or district an user that has an access to the physical line can look over the data not intended for him. With the aim of priv in different combinations used access control, authorizing and enciphering of information, complemented by back upping. Usually at first it is necessary to analyze threats, to vulnerability and defense of the operating system. The analysis of risk must give the objective estimation of many factors (propensity to violation of work, probability of violation

of work, loss from losses, decline of coefficient of readiness of the system) and give information for determination of suitable types and strength securities. Today all more organizations open out the rich up-diffused databases and program, client / server for the management of commercial data. At the increase of distribution grows also and risk of the unauthorized access to data and their distortion.

Research and analysis of informative safety of the different distributed calculable systems confirm circumstance that, regardless of the used network protocols, topology, infrastructure of the distributed calculable systems, mechanisms of realization of threats are invariant in relation to the system. Clear is a statement that, for a success attack most violators will carry out even the superficial monitoring of network, construction of her map, and determination of points of be vulnerable network structure and network traffic.

As a number of users of the different off-line systems grow incessantly, sharply the question of differentiation of their plenary powers appears in the informative system. There are two types of lists of access control. The first works at the level of users and shows by itself the mechanism of defense of resources of such, as files and folders. The second type of access control is a system list of access control and control mechanism above the reports of audit that is related to the informative resource, id est. amount of attempts of access. Work of lists of access control is based on creation of records of access control, in that the identifier of safety of user combines together with the mask of access. It is necessary to notice that the combined variant (with a password, with the category of secrecy of information, with the mechanism of policy of safety) works effectively.

The tools of priv can not be designed, to buy or set to the pore, while a corresponding analysis is not done. It is necessary to develop the politician of mechanisms of defense and safety of information at planning of the informative system.

Conception a «client-server» provides for, that every technological procedure requires the presence of elements: client that asks information; server that gives this information; actually networks. For this architecture of network it comfortably to use system of defense of Kerberos. Enciphering of data was traditionally used by governmental and defensive departments, but in connection with the change of necessities and company begin to use possibilities that get to enciphering for providing of confidentiality of information - for example distribution of permissions in the controlled from distance education, on - line studies.

System of protection fetch to the network is protocol of Kerberos. The system Kerberos, worked out by the participants of project of Athena, provides the protection of network fetch, being based exceptionally on programmatic decisions, and foresees the frequent enciphering of the information passed for networks. Kerberos provides authentication of users of network and servers, being not base on network addresses and feature of the operating systems of the work stations of users, not requiring a physical priv on all machines of network, coming from supposition, that packages in a network can be easily counted and at a desire changed. Description of protocol of KERBEROS [2, 5, 6] gives an opportunity to separate basic properties that protocol of authentication and also widespread defects that usually happen in such most

protocols, must own:

- Protocol does not protect from attacks the class of "DoS".
- Participates must keep in secret of the secrets - protocol does not provide defence in case of loss of secret.
- Protocol does not protect from attacks as "Unravelling of password": choice of reliable password that serves as a secret or on that a secret is built, abandoned at discretion of participates.
- The system clock of all participants of authentication process must be synchronized, providing of safety of synchronization is attributed to the functions of additional protocol of synchronization.

New participates must not inherit the identifiers of old, withdrawn from the system (networks); otherwise they can inherit their permissions. Kerberos in a considerable measure Needham-Schroeder based on protocol, but with two substantial changes:

- First change of protocol diminished the amount of reports sent between a client and server of authentication.
- Second, more substantial change of base protocol, consists in the conduct of TGT (Ticket Granting Ticket is a ticket for the receipt of ticket) of conception, that allows to the users of authentication on a bit services using the confidence data only one time.

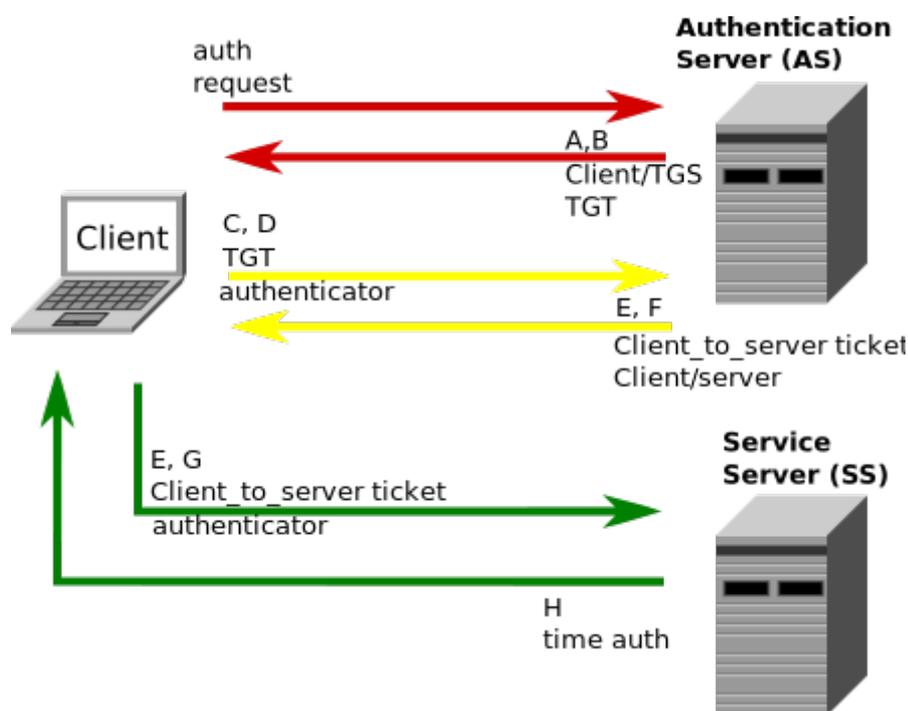


Fig.1 Chart of work of the system Client / Kerberos / Server

Kerberos has a structure of type client / server and consists of the client parts set on all machines of network (work stations of users and servers), and Kerberos of server, located on some computer. Kerberos of server, in turn, divided by two equal in rights parts: authentication server (SA) and server of delivery of permissions (TGS - ticket granting server) (fig.1). These components are supplied usually as an only program that is started on the centre of distribution of the keys (contains the database of login/passwords for users and services that use Kerberos). The server of

authentication performs one duty: gets a query that contains the name of client that asks authentication, and returns to him in cipher TGT. Then a user can use this TGT for the query of further tickets on other services. In most realization of Kerberos time of life of TGT 8-10 hours. After it a client is again guilty to invite him in SA. It should be noted that there is the third server of Kerberos that, however, does not participate in authentication of users, but intended for administrative aims. The environment of action of Kerberos (realm) spreads to the that area of network, all users of that are registered under the names and passwords in the base of Kerberos of server and where all servers have the general code key with identification part of Kerberos. In an order to avoid troubles of Kerberos, applies the difficult system of the frequent enciphering at an information transfer in a network. An identification server is addressed to the database that keeps information about all users, and on comparing to the name that is contained in washed down user, its password determines. «Permission is then sent a client on the receipt of permission» and special code of session (session key), that is coded by means of password of user, as a key.

At the receipt of this information a user at its work station must enter the password, and if he coincides with that is kept in the base of Kerberos of server, «permission on the receipt of permission» and code of session will be successfully deciphered. A problem is thus settled with defense of password — in this case he is not passed for networks. One of advantages of protocol consists in that a client can be authentication and to get access to the server of resources out of the area of authentication — domain, on condition that both trusted server, that serve the areas, set inter se confidence relations (defined the general key of enciphering at sending of data between areas).

Conclusions.

The analysis of aspects of threats of violation of properties of information is conducted in the article, a plan over of development of constituents of policy of safety of informative threads and certain mechanisms of maintenance of confidentiality of information are brought in the network of transmission.

The problem of defense of computer and of communication networks from an unauthorized division purchased the special sharpness. Informative space is necessary to be protected.

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J11510-035

Popov S.N., Il'ina E.A.

**DESIGN OF THE USER INTERFACE FOR CREATION THE
REFERENCES LIST**

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Abstract. Design of the user interface for creation and working with the references list was analyzed in this article. The definition of term "interface" was determined and its importance while developing the software was characterized. The 3 design aspects were introduced. Each of these aspects was opened in terms of design software. The user dialog structure was analyzed. Quantitative analysis of developing software, based on classical GOMS model, allows to predict the time, the experienced user needs to execute specific actions using this interface model.

Keywords: interface, screen forms, the structure of the dialogue, a quantitative GOMS model, the time interval.

Work relevance.

Interface is one of those words developer is not usually think about. There are several definitions of the word "interface". User interface is the set of problem area informational model, interaction means and interaction methods between the user and the informational model and also informational model formation components.

In wide sense, the interface includes all of things, which are helping user to interact with the PC, including documentation, learning and technical support [1, 2].

User interface design must be approved and accepted by the users. Even outstanding systems without good conceived interface won't be successful.

Design of the user interface

In the design of the user interface it is necessary to activate the users attention while working with the software interface, to organize the dialog structure in the automated system, to make the user interface quantification.

In the process of the software method designing for creation the references list, the user's attention is activated in connection the MS Word 2010/13 backdrop.

The content of the window is one-typed: the software name, the developer requisites, one of the basic software metaphor, developing time period, version number, etc.

Choice of the dialog structure is the major stage, which must be completed while the interface design. The dialog in developed system, based on the screen forms, allows the processing of different answers at the one dialog step. In practice the forms are using in areas, where the accounting of any actions requires the input of the standard dataset. The man, who fills out the form, can choose the answer sequence, can temporally pass through the questions, can go back for correction of the previous answer and he even can "delete the form" and start to fills out new one.

Software helps the user to work with the form until he fills out it and sends it to the system. Software checks every answer after filling out the whole form. Also, the filled out by the user information, becomes available only after "Enter" keystroke at the end of fill out the form. That is why, this structure can be used in areas, where the

data source is the existing inbox ("paper") document's form.

In developed software all of the necessary input units can't be shown in the same time within the limits of the screen (or window) and it is necessary to split them into groups, which are displayed on the screen (window) sequence.

And that is why the grouping of the references list design versions has been made. Some of the bibliographic sources, for example the book of one author, the book of two authors, the book of three authors, were merged into one bibliographic source type, because the design of these sources is the same according the all-Union State Standard.

Also, the source types, such as the book of four authors, the book of five authors, the book edited by, were merged too.

The source form "Dictionaries, guides, encyclopedia" was associated with the source type "book" or with the source type "multi-volume edition" because of the equal design. It is important for this splitting to save the logic connections and to avoid the split of the related parts of the document [3-8].

The structure of the dialog, based on the screen form, ensures a high user support level: for each form question the error messages and the guide information may be shown.

Also, the user can get some help by including some of the answer format elements into the question or the question field.

There are a lot of methods for quantitative interface analysis. One of the best way to quantitative model analysis is the classic model GOMS – «the rules for goals, objects, methods and selection» (the model of goals, objects, methods and selection rules). The GOMS modeling allows to predict how much time the experienced user needs to execute specific action using this interface model [9-10].

The set of the time intervals was received using the laboratory investigations. These time intervals requires for executing different actions. There is an original nomenclature where the each of the interval shows by one letter in table 1.

Table 1

The nomenclature of the time intervals for the interface quantification

<i>Designation</i>	<i>The time interval, sec</i>	<i>Description</i>
K	0,20	A keystroke. The necessary time for typing a key.
P	1,10	An indication. The necessary time for user to indicate on some position at the monitor screen.
H	0,40	A displacement. The necessary time for user to move the arm from the keyboard to the graphic input device and from the graphic input device to the keyboard.
M	1,35	A mental preparing. The necessary time for user to prepare its brain for the next step.
R		A response. Time for user to get the response from the computer.

The view of the user tab for creation the references list is shown on the figure 2.



Figure 2 – The view of the user tab

Description of the GOMS model performs due to adding a new actions.

The algorithm of getting the operators sequence for paste the already existed bibliographic record is shown in the table 2.

Table 2

The algorithm for getting the operators sequence

<i>Description</i>	<i>Operators order</i>
Moving the arm to the graphic input data device	H
Moving the cursor to necessary switch key in the group	H P
Clicking on the necessary switcher	H P K
Indication the position on the monitor screen	H P K P
Clicking on the necessary switcher	H P K P K
Clicking on the necessary switcher	H P K P K K
Moving the cursor to necessary switch key in the group	H P K P K K P
Clicking on the necessary switcher	H P K P K K P K
According the rule 0, put the operator M before all of the operators K and P (excluding the operator P), pointing out on the arguments which are misses in this line.	M H P M K P M K M K P M K

Since the existing references list can has a different quantity of bibliographic records, the user needs to move the cursor to the necessary switcher in the process of choosing the source to the each link.

According the time intervals in the table 2, we received the time:

$$M+H+P+M+K+P+M+K+M+K+P+M+K = 1,35+0,4+1,1+1,35+0,2+1,1+1,35+0,2+1,35+0,2+1,1+1,35+0,2 = 11,25 \text{ seconds.}$$

This is the time for user to add the text link on the already filled bibliographic source. This time evaluation shows that there is no sense in determination more complicated structures not only for data display, but also for data input, which means that the user interface style has been chosen reasonable.

Conclusion

As the result of analysis of design the user interface for creation the references list the term "interface" was determined. Well-made interface helps user to interact with the computer successfully. The main design tasks were described, specifically to attract the user attention, to organize the dialog structure, to make the interface quantification. In developing automated system the existing MS Word 2010/13

backdrop is using. The dialog structure, based on the screen forms, is organized. The original nomenclature of the time interval while the interface quantification is shown. The actions method in terms of GOMS model is described.

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**RESULTS MANAGEMENT INDEX ANALYSIS OF PUBLICATION
ACTIVITY RESEARCH AND TEACHING STAFF UNIVERSITY***FSBEI HPE “Nosov Magnitogorsk State Technical University”,
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Abstract. The paper deals with one of the most important characteristics of the activities of scientific organizations - publication activity. Shows a diagram of the structure of educational organization and management principles of publication activity. In this paper, the values of two input indices: basic and chain, as well as an index analysis made on the basis of their. In this context, the chart shows the index for the assessment of the main indicators of publication activity of researchers and teachers in journals indexed in international databases Web of Science and Scopus.

Key words: publication activity, the core index, chain index, index analysis, Web of Science, Scopus.

Introduction. The modern institution of higher education and research organizations operate in a competitive market. Requirements of scientific and educational markets determine the need to develop a set of indicators to assess the rating organizations, which in turn seek control actions on them. One of the characteristics of universities and research organizations is the publication activity of the organization as a whole and individual academic staff (AS). Indicators publication activity of the organization and individual scholars have acquired the status of indicators of demand research results [1, 2]. Much attention is paid to the problems of effective management of publication activity of research teams, which in turn requires the determination of the structure of publication activity and its impact on the projects of the organization and the choice of effective management measures (Fig. 1).

The highest result management publication activity in the organization is to achieve such values of the indicators that allow the nomination of scientific developments on the domestic and foreign markets, as well as raising a high position in the rating systems, which leads to an increase in consumer activity among potential students and employers [3, 4].

The structure and governance of publication activity. The structure of the publication activity typical educational organization consists of three main components: a publishing project within the organization, the publication in Russian publishing houses various status and publications in foreign publishing houses (Fig. 2). Each component of this structure is constructed image types and includes: the publication of articles in journals and books, publication of theses and reports on the results of the conference, monographs, educational materials, etc.).

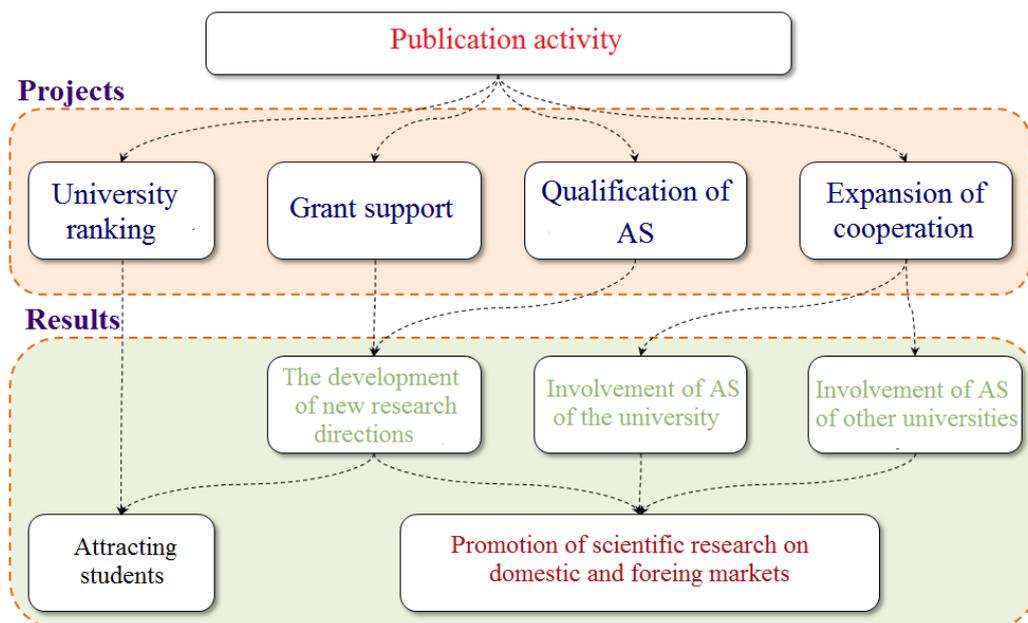


Fig. 1. Scheme influence of publication activity indicators on the performance of a typical educational organization

Process control features of publication activity in the context of publishing project are: analysis of the results, monitoring activities, taking into account the results, information support processes and stimulate artists (Fig. 3).



Fig. 2. The structure of the publication activity typical educational organization

The combination of all the components of the management process of publication activity allows: to obtain reliable information about the course of the process and to take effective decisions regarding activities planned in the previous and next periods. One element of process management is the analysis of the results obtained in the last period on the basis of management decisions.

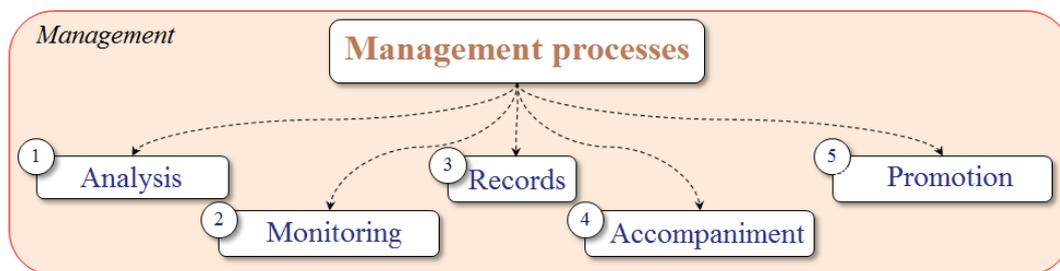


Fig. 3. Block diagram of the control process of publication activity in higher education

The main principles adopted in the management of publication activity:

- continuous monitoring, information support and integration of project results publication activity;
- system in the sensitivity analysis and performance management change impact indicators publication activity;
- adaptive management decisions to change the values of the indicators of publication activity;
- validity of motivation and stimulation effects of changing values of publication activity.

The results of the analysis of indicators of publication activity educational organization

Most of the studies carried out on the basis of an analysis of the absolute values [5]. However, the use of index analysis allows to analyze not only the dynamics of absolute performance, but the effectiveness of the decisions made in the current period [6, 7].

For the analysis of management actions in 2014 on the performance of publication activity in FSBEI HPE «Nosov Magnitogorsk State Technical University» we introduce two types of indexes:

- base index number of publications and citations of scientific-pedagogical staff (1):

$$B_i = \frac{K_i}{K_0}, i = \overline{0, n}, \tag{1}$$

where B_i – the value of the underlying index in the current i -period; K_i – the absolute value of the indicator in the current i -period; K_0 – the absolute value of the index in the basic initial period; n – the number of the study period;

- chain index number of publications and citations of scientific-pedagogical staff (2):

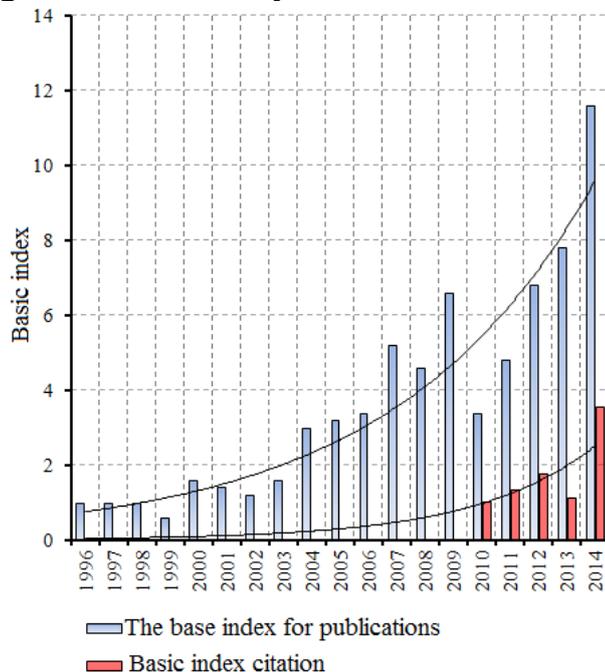
$$C_i = \frac{K_i}{K_{i-1}}, i = \overline{1, n}, \tag{2}$$

where C_i – the value of the underlying index in the current i -period; K_i – the absolute value of the index in the current i -period; K_{i-1} – the absolute value of the index in the previous period; n – the number of periods studied.

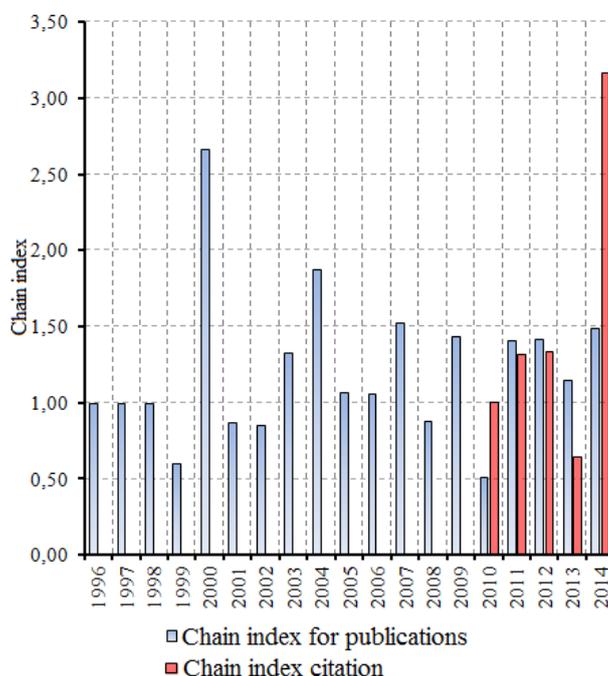
Figures 4 and 5 are diagrams for the assessment of base and chain index on the main indicators of publication activity of researchers and teachers in journals indexed in international databases Web of Science and Scopus.

As the base period for research publication activity was selected in 1996, which

allowed the dynamics of the 20 years to track changes in indicators of citation and the number of publications indexed in major scientometric systems Web of Science and Scopus. Since 2011, the leadership of educational organizations are monitoring and analysis of publication activity and in 2013 carried out information support and incentives for employees who have published their scientific achievements in journals indexed in foreign scientometric systems.



a



b

Fig. 4. The results of the analysis of indicators index publication activity in journals indexed in Scopus:

a – dynamics of the base index; b – dynamics of chain index

A steady trend towards a power increase ($R^2 = 0,86$) the number of publications in journals indexed in scientometric system Scopus (Fig. 4a) for the benchmark index by 1996. However, in the same system no clear trend between the current and the previous period, suggests that the insufficient implementation of the

principles of consistency and adaptability in the management of publication activity of the organization to ensure the increasing dynamics of the chain index.

Also not seen a stable trend in the growth of value indicators publication activity in scientometric system Web of Science. Actually find effective solutions to manage the process of publication papers and their citation for this system (Fig. 5b). The dynamic range of the base and the chain index are random and have not yet managed trend.

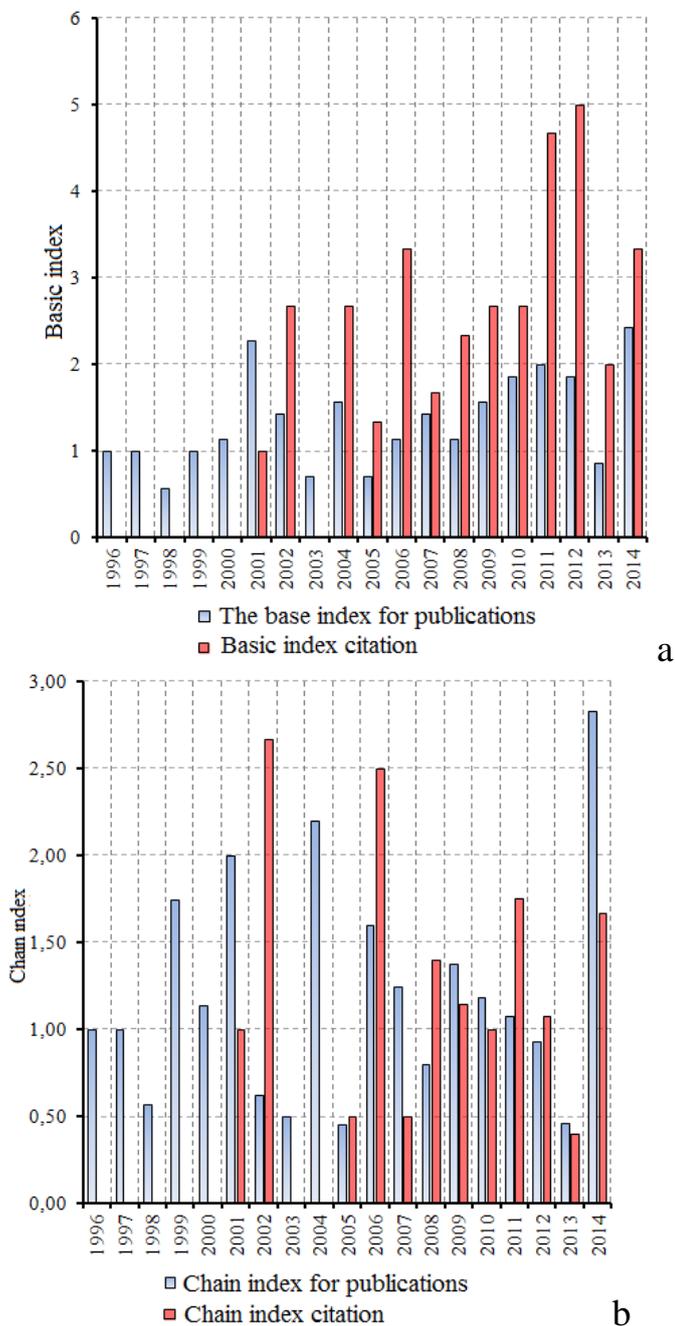


Fig. 5. The results of the analysis of indicators index publication activity in journals indexed in the Web of Science: a – dynamics of the base index; b – dynamics of chain index

Summary and Conclusions

1. Analysis of the structure of publication activity typical educational organization revealed the presence of three components having the same

composition. Among these three components most susceptible to control actions is the publishing project of the organization. However, to improve the rating and market indicators required to consider all projects at the same time and a lot of attention paid to the publication of papers in international journals.

2. Management of the publication activity can be effective if fully complied with the proposed principles are: continuity, system, adaptability and validity. All the proposed guidelines should be implemented together as a full screen and the individual components of the project and in the total population.

3. At analyze the results of effective management should be used integrated indicators that demonstrate not only the dynamics of changes in the absolute values of the publication activity, but also the effectiveness of the decision on the early stages of the study. Those indicators integrated assessment can serve basic and chain indices.

4. The results of publication activity index analysis of scientific and teaching staff of the university model has shown a lack of effectiveness of the management decisions to stabilize the trend for growth in scientometric indicators Systems Web of Science and Scopus.

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**UNDERWATER INDEPENDENT BIOTECHNICAL COMPLEX OF
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Abstract. In work the underwater modular technical complex for technologies of marine aquaculture and land improvements of the sea environment which basic element is the immersed platform hydraulic engineering installation breed sea organisms, with the independent power supply automated by the control and management, surface service by standard receptions of fleet is considered. The opportunity of use of energy of superficial sea wind waves for independent power supply of the underwater technical complex is discussed at large-scale development of plantations sea of marine aquaculture.

Keywords: independent, the automatic, biotechnical complex, wave power installation, control and management, of marine aquaculture, a shelf.

The introduction. High rate of growth of manufacture of sea foodstuff, strengthening of anthropogenous pollution of Ocean and modern condition of development of underwater sea technologies create the precondition for step growth of development of the sea environment with an opportunity of accommodation of underwater plantations гидробионтов of marine aquaculture in a shelf zone of the high sea. Existing coastal sea farms of the open type basically use hydrobiotechnical constructions for культивирования in the closed or half-closed coastal water areas of bays, gulfs, sites of the rivers. Thus the coastal zone of rest is torn away, water exchange of estuaries is at a loss, the bottom gets littered with building waste and written off sail, there is a periodic destruction of underwater plantations of marine aquaculture to storm, handicapes to fishery and navigation are created. The coastal enterprises of marine aquaculture owing to not isolation of work cycles bring the contribution to biological pollution of sea water areas.

Result of functioning of facilities sea of marine aquaculture is not only a food biomass of animals and plants, but also cleared from waste of a civilization water. Under such corner of sight it is necessary to consider influence of facilities of marine aquaculture on coastal sea экосистемы as quality of the water environment as a whole, and sea in particular, has not only ecological, but also economic value for an estimation of suitability of use of these water resources in of marine housekeeping and the recreational purposes.

The ecological engineering in systems of land improvement of sea reservoirs widely uses methods of marine aquaculture for biological clearing the waters, including cultivation different kinds of seaweed and animals, in fact both these technologies are based on an identical principle of use of natural processes of circulation of substance and energy for extraction of advantage in the form of received bio-production and pure water.

The review of the literature. The purpose of ecological engineering concerning use and processing of the sea waters, exposed to anthropogenous influence, is

improvement not only parts sea биоценозов, but, also, complete экосистемы and not only maintenance of direct needs for ecological safety in present time, but in long-term advantage in the future [1].

It is impossible to bypass a question of functioning of plantations of marine aquaculture and their influence in regulation of a degree of pollution of coastal water areas. The greatest efficiency at macrophyts marked at the maintenance of nitrogen in sea water 100 g/cube the m. Such concentration arise in areas of an intensification of an agricultural production with an output of waste waters from fields in sea water areas through river drains and places of release of sewage of fish remaking the enterprises. It is established, that young laminary in the length 1-2 m for the growth daily consume 6 mg of nitrogen. It is obvious, that in this case plantations laminary of marine aquaculture can be the powerful biofilter.

Among the organisms-filtration organisms which are grown up in conditions of marine aquaculture, the first part are folding molluscs. It is revealed, that one mussel in weight of 8 grams in an hour filters about four litres of water, for a day 1 ton of mussels filters cube up to 1,8 thousand m³ of water, year of 1 hectares of midys plantations it is capable to clear up to 3 million m³ waters, taking from it up to 9 thousand tone bacteria [2]. Use of biotechnical system in the form of resulted in work [3] has shown a plantation an opportunity actively to struggle with oil pollution with exceeding maximum concentration limit from 1 up to 100 (0,05-5,0 mg/l), thus molluscs - filtration organisms do not lose the activity on clearing sea water at concentration of mineral oil in 5-8 mg/l, i.e. exceeding size of maximum concentration limit in tens times.

Hydrobiological ways of struggle against the pollution, using technologies of marine aqua [3,4,5,6] are available and developed.

Entrance data and methods. The analysis of experience of long operation of hydraulic engineering constructions for needs of marine aquaculture shows, that used technologies are based on the out-of-date principles and low on labour productivity operational processes. Existing development of means of functioning of plantations of marine aquaculture have greater restrictions in the sizes, on depth of their installation, of storm, on object cultivation uleted and many other things to parameters. For needs of marine aquaculture basically it is used top coastal sea water areas of a shelf zone up to depths 20-25m.

One of ways of the decision of a problem of an opportunity of large-scale use of available technologies of marine aquaculture and systems of land improvement of coastal shelf water areas is expansion of functionalities of the hydraulic engineering constructions used for creation of plantations of cultivation гидробионтов up to depths of 60-80 m. With this purpose the underwater biotechnical complex which basic element is modular immersed platform the independent automated biotechnical design (Installation) cultivation various kinds sea гидробионтов, with the independent power supply automated by the control and management, surface service by standard receptions of extracting fleet, without diving works is developed (fig.1).

Results. Discussion and the analysis. The underwater biotechnical complex contains the wave power device for independent power supply of work of devices and mechanisms in the form of a floating pontoon with the rigid case [7, 8], circle a

design with positive buoyancy for культивирования sea organisms (Platform), electro-winch about a cable-cable, system of buoyancy with the pipeline of compressed air, station of the automatic control and management, an anchor.

The platform has cables-collectors for accommodation of grown up sea animal filtration organisms or seaweed which are attached by the bottom ends to units of the second circle of a design of a platform of a grid-pallet. The grid-pallet is fixed on a cable-cable extensions of a lattice and can be used for cultivation another animals sea.

In the case of a pontoon of the wave power device are located the air pump with the spring-piston mechanism, memory capacity for compressed air with standard

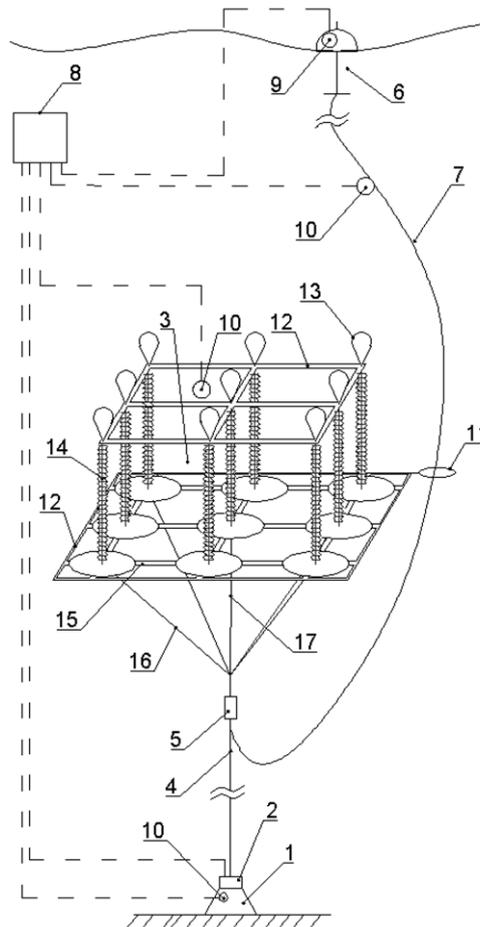


Fig.1. Automatic independent installation of cultivation гидробионтов:

1-ground anchor; 2 – cable-electro-winch; 3 - the Platform; 4 - an anchor cable-cable; 5 - automatic mechanical spring -piston the air valve; 6 - the wave power device; 7 - a cable-cable with the air pipeline; 8 - the automatic program block of the control and management with a dispatching satellite communication; 9 - the complete set of gauges: a charge of the accumulator, pressure of air in a pontoon and heights of superficial waves; 10 - the complete set of gauges of depth, light exposure, temperatures, salinity, the maintenance of oxygen and speed of a water stream; 11 - a rigid loop; 12 - a hollow lattice from pipes; 13 - elastic floats; 14 - cables-collectors with hydrobionts; 15 - a grid-pallet; 16 - flexible delays; 17 - a cable-cable with the air pipeline.

safety and distributing редуцирующим valves of pressure and the connecting pipelines connecting system of compressed air with the Platform, the electro-generator and the electro-accumulator for maintenance of the module with an

electricity. Besides in the rigid case of a pontoon of the wave device there is a block of the local automated control and management of the modular complex, connected by a satellite communication with dispatching service (рис.2).

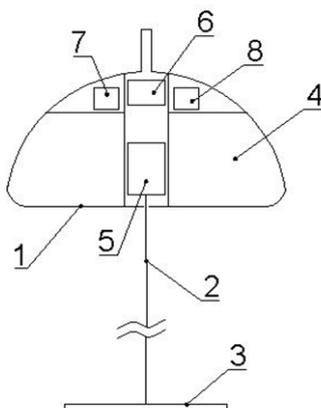


Fig.2. The wave power device:

1 - a rigid pontoon; 2 - a cable-cable with the air pipeline; 3 - a flat rigid floating anchor with valves of unilateral transmissivity; 4 - capacity for compressed air; 5 - the spring-piston pneumatic mechanism; 6 - the electro-generator; 7 - the electro-accumulator; 8 - the block of the control and management with a dispatching satellite communication.

The system of automatic buoyancy of the Platform contains a hollow lattice-skeleton from rigid pipes of positive buoyancy with delays fixed on anchor a cable-cable, elastic floats the lattices-skeletons attached in units from above, the safety valve of pressure is located on an input of compressed air in a cavity of a lattice-skeleton. Besides into system of buoyancy of the Platform enters mechanical spring piston the air valve located under the Platform on anchor cable-cable which serves as a regulator of maintenance of constant positive size of buoyancy of the Platform at its accommodation in thickness of water and for preservation of size of a tension anchor a cable-cable irrespective of depth and a growing total biomass hydrobionts.

The block of the local independent control and management with a dispatching satellite communication has gauges of height of superficial waves, pressure in memory capacity of compressed air and system of buoyancy of the Platform, sizes of a charge of the electro-accumulator. Besides the block of the control and management is supplied by gauges of the control of the water environment (depth, light exposure, temperature, salinity, the maintenance of oxygen and speed of a water stream), located on a cable-cable at a bottom, on the Platform and at a water table.

Automatic change of depth of an arrangement of the Platform is adjusted by a choice of optimum daily and seasonal ecological parameters of a surrounding water layer of the water, defined by means of gauges of the control of the water environment, for an intensification of a mode of growth of a biomass grown up гидробионтов.

Anchor cable-electro-winch which is attached to an anchor through the swivel, provides to the Platform change of depth and rise with a surface in automatic and operated modes through a satellite communication the dispatcher that enables to reduce danger of destruction of a design as a result of influence of storm and allows to make installation and removal of the Platform without diving works.

In the sea in a transport condition Installation deliver to a place of statement by

providing vessel-dock. Moving cultivated гидробионтов on cables-collectors and a grid-pallet make on a vessel the-dock which is being in погруженном a condition for maintenance of water in pools of a vessel with sea гидробионтами before statement of Installation in a reservoir. On arrival on a place of statement collect Installation on a deck without connection of cables-collectors and check working capacity of all systems. After check in system of compressed air dump pressure, then the vessel of maintenance plunges up to a main deck, the Platform with floats emerges on a level of a deck and to a lattice attach cables-collectors with гидробионтами. Establish Installation on a workplace ship load-lifting means for the set depth and, further, the complex passes in an independent program operating mode. Further there is a process of cultivation гидробионтов up to the set commodity characteristics of cultivated organisms to automatic control of a tension a cable-cable at increase of a biomass hydrobionts, with an opportunity of change of depth during the daily, seasonal periods and at approach of a storm. Upon termination of process of cultivation and the approach of a serving vessel of-dock the dispatcher gives a command to the block of management on a satellite communication on rise of the Platform on a surface. The sizes of the module of Installation are limited to the sizes of an immersed deck of an auxiliary vessel of-dock.

The conclusion and conclusions. Energy needs of a underwater biotechnical complex of marine aquaculture are provided with wave power installation through the electro-accumulator and capacity with a stock of compressed air, of charger the electro-generator and the piston pump. For example modular Installation in the size 20x20 m for cultivation of organisms of filtration organisms (filtering molluscs), having 1000 collectors, with initial weight of cultivated sea organisms on collectors of 2 kg/m² before achievement of commodity weight on collectors of 200 kg/m² within a year will consume the electric power on change of depth, work of gauges and the block of management with a satellite communication 28 kw*hour on the average for a day. On the mechanical air pump, at change of depth of the Platform with difference 20 m and a stock with frequency rate 2, the electric equivalent capacity 0,25 kw is required. For the period of cultivation in 1 year it is required 12410 kw*hour. Demanded wave power installation with average valid capacity 0,4 kw. Parameters (sizes) of wave power installation, at the given capacity, also are defined by the meteorological forecast of an installation site and the size of the accumulator of compressed air. For the open part of Peter the Great bay (sea of Japan) is required wave installation, approximately, with diameter of a pontoon up to 1,5m and weight up to 1000 kilograms.

The complex of marine aquaculture has been developed underwater biotechnical, basic which modular element is immersed independent automatic Installation cultivation sea animals, with surface service by standard receptions of extracting fleet, without diving works.

The automatic monitoring system and managements of technical designs and devices of a underwater complex for cultivation гидробионтов in water thickness of shelf water areas up to depths of 80-100 m for creation of scale plantations in coastal water areas of a shelf has been considered.

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J11510-038

Gun'ko S.M., Trynchuk A.A., Potanin D.V.
EFFECT OF STORAGE CONDITIONS ON RESPIRATION RATE AND
HEAT RELEASE IN MUSHROOMS OF CHAMPIGNON BISPORED
DURING ITS STORAGE

In world has seen a rapid increase in production and consumption of cultivated edible mushrooms which are a source of easily digestible plant protein. Mushrooms champignon bisporoid are leading among their. Process of mushrooms storage was accompanied by physiological processes which affect on intensity change of merchantability and loss of weight. The influence of storage temperature, duration of storage and wave fruiting of mushrooms champignon bisporoid on the physiological processes – respiration rate and heat release were presented in the article. The results were the dynamics of changes in these indicators during time of storage and determined major factors influencing their quantitative value.

Key words: mushrooms, champignon bisporoid, storage temperature, storage time wave fruiting, physiological processes.

Introduction. Statistical data of United Nations of Food and Agriculture indicated that the population of our planet's food is a major concern. The main problem is the lack of protein and its imbalance in the diet of people. In recent decades there has been a rapid increase in production and consumption of cultivated edible mushrooms in fresh and processed form [1, 2]. Scientists project that in the future, much of the necessary human proteins will be satisfied from the industrial production of edible mushrooms. Today in Europe and the CIS countries is one of the leading places among the cultivated mushrooms of champignon bisporoid [3-5].

After start storage in mushrooms continuing physiological processes, which affect on the intensity change of merchantability and loss in weight. The main among these processes are respiration rate and heat release.

Therefore, the aim of our study was to determine the effect of different temperatures, duration of storage and wave fruiting on the intensity of physiological processes in mushrooms champignon bisporoid.

Materials and methods. Research work carried out in the laboratory of mycology, processing and storage of vegetable products Kyiv Research Station industrial vegetable National Scientific Centre "Institute of Mechanization and Electrification of Agriculture" NAAS Ukraine.

Champignons bisporoid strain IBK-25 used in the studies. Mushrooms stored during 6 days at a temperature 1, 3 and 5 °C and relative humidity - $90 \pm 1\%$. Repeatability is four. Control was production, which kept the temperature 1°C. Mushrooms kept in cold rooms with a working volume of 6 m³.

The experiments were made with mushrooms first and second waves of fruiting.

The experiments were made with mushrooms first and second waves of fruiting.

Respiration rate fungi were determined experimentally in a desiccators, every day during storage, the technique based on the absorption of carbon dioxide alkalis (Ba(OH)₂) with known concentration with further determination amount of alkali that the titration unreacted acid (HCl). Simultaneously conducted titration with alkali

products desiccators without (control). Respiration rate (RR) was determined by the formula:

$$RR = \frac{(K - \delta) \cdot a \cdot 480000 \cdot T}{m \cdot \epsilon \cdot t}, \tag{1}$$

where RR - respiration rate, mhCO₂/kg•h;

K – amount of acid spent for titration control ml;

δ – amount of acid spent for titration experiment, ml;

m – weight of fruiting body mushroom, g;

t – time stay of mushrooms in a desiccator, min.;

T – correction to the titre 0,1 m of alkali;

a – average between atmospheric pressure at the beginning and end of the experiment;

ε – average between the temperature at the beginning and end of the experiment.

The amount of heat released by mushrooms was determined by the amount of CO₂ released during aerobic respiration. Each gram of carbon dioxide, a dedicated breathing spent 2.553 kcal or kJ 10.69. Thus the final formula is as follows:

$$A = B \cdot 10,69 : 1000 \cdot 24, \tag{2}$$

where A – heat release of production, kJ/kg•day;

B – respiration rate, mgCO₂/kg•h.

Results. Thus, at a temperature of 1 ° C after one day of storage depending on the wave of fruiting respiration rate increases (table 1) from 3,9-4,1 to 7,8-8,8 mgCO₂/kg•h.. This indicates that the normal process of opening hat of mushroom accelerated after cut of fruit body. Therefore after cutting, mushrooms continue to grow, affecting the intensity of their breathing. After stabilization of temperature and humidity in the chamber decreases evaporation from the surface of mushroom and growth processes are inhibited, respiration rate begins to decrease until the end of storage. On the sixth day the amount of carbon dioxide equal 2.3-2.9 mgCO₂/kg•h.

Table 1

The intensity respiration rate mushrooms of champignons bispored during its storage at different temperatures, mgCO₂/kg•h

Temperature of storage, °C	Before storage	Durations of storage, days						
		1	2	3	4	5	6	average
<i>the first wave of fruiting</i>								
1(control)	4,1	8,8	10,8	4,7	2,8	2,6	2,3	5,2
3	4,3	11,2	11,5	7,2	4,3	3,9	2,5	6,4
5	3,9	13,1	13,8	10,3	5,3	4,7	6,8	8,3
<i>the second wave of fruiting</i>								
1(control)	3,9	7,8	10,4	4,4	4,0	3,4	2,9	5,3
3	3,6	11,5	12,3	7,1	6,3	4,3	3,6	7,0
5	3,8	13,8	14,4	10,4	6,5	4,8	7,0	8,7

On the amount of carbon dioxide released during respiration fruiting bodies of mushrooms after harvesting affects temperature storage. On the second day, at a temperature of 1 °C, the intensity of respiration is 10,4-10,8 mgCO₂/kg·h depending on the wave of fruiting at 3 °C – 11.5-12.3 and 5°C – increases to 13.8-14.4 mgCO₂/kg·h. For storage temperature 5 °C from fifth to sixth day of storage, an increase in the intensity of respiration from 4.7-4.8 to 6.8-7.0 mgCO₂/kg·h, indicating the beginning of aging fruit body and preparing it for opening hat mushrooms and release of spores.

Based on data from breathing intensity calculations of heat release of mushrooms. Heat release mushrooms varies similarly respiration intensity (Table. 2).

Table 2

Heat release mushrooms of champignons bispored during its storage at different temperatures, kJ/kg·day

Temperature of storage, °C	Before storage	Durations of storage, days						
		1	2	3	4	5	6	average
<i>the first wave of fruiting</i>								
1(control)	1,0	2,2	2,7	1,2	0,7	0,7	0,5	1,2
3	1,1	2,8	2,9	1,8	1,1	1,1	0,6	1,4
5	1,0	3,3	3,6	2,6	1,3	1,2	1,7	1,7
<i>the second wave of fruiting</i>								
1(control)	1,0	2,0	2,6	1,1	1,0	0,8	0,9	1,0
3	0,9	2,9	3,1	1,8	1,6	1,1	0,8	1,7
5	1,0	3,5	3,7	2,6	1,7	1,2	1,8	2,2

The highest heat release (3.6-3.7 kJ/kg·day) observed at a temperature of 5 °C storage. Lowering the temperature of storage provided to reduce heat release to 2,9-3.1 at 3 °C and 2,6-2,7 kJ/kg· for 1 day at 1 °C.

Using the results of heat mushrooms defined productivity ventilation during storage. For quick cooling of 1 ton of mushrooms from 17 to 5 °C cooled air supply should be at least 4456 m³/h. Upon reaching optimum storage temperature, ventilation activity can be maintained at approximately 645 m³/h.

Keeping quality mushrooms fruiting second wave is slightly lower than the keeping quality fruit bodies and immediately fruiting. This dependence obviously associated with reduced activity of compost, loss of nutrients, as well as the appearance of bacterial, viral and fungal infections. But, at the same time, a significant difference between the two options is most insignificant in appearance and almost invisible.

Conclusions

Question of influence temperature, duration of storage and waves of fruiting mushrooms of champignons bispored on the intensity of the flow of basic physiological processes were considered. As a result, it was found that after starting of mushrooms storage their breathing intensity increases, which associated with the

end of ripening process, and then decreases. On the second day of storage this indicator is from 10.5 to 14.2 mgCO₂/kg·h, depending on the temperature and wave fruiting. Further respiration rate decreases to 2.5-3.0 mgCO₂/kg·h.

Dynamics of heat release associated with respiration rate, has the same trend varies from 0.5 kJ/kg·day at the end of storage to 3.7 kJ/kg·day on the second day. Temperature, time of storage and wave fruiting mushrooms of champignons bispored were main factors influence the intensity of physiological processes there.

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BIOENERGY IN UKRAINE*National university of life and environmental sciences of Ukraine**Kiev, Heroes of Defense, 12, 03041*

Abstract: The analysis of efficiency of application of the main types of solid biofuels in Ukraine in comparison with the efficiency of use of natural gas and coal. These recommendations regarding the use of solid biofuels

Keywords: pellets solid biofuels, power plants, heat of combustion, energy efficiency, natural gas, coal

Introduction. In recent years, has become particularly topical issue of Ukraine's energy, because of its own reserves of natural gas and oil in our country is only enough for 20% of the needs [1]. With the outbreak of war in the Donbass Ukraine also left without reserves of thermal coal, which we have to buy. Therefore it is necessary to search for alternative fuels, which would be able in the short term completely or partially replace fossil fuels. One such alternative fuels is a solid biofuel: energy wood, energy crops, which are used for burning plant matter (miscanthus, schavnat, Jerusalem artichokes, etc.), agricultural residues and timber production. Energy from biofuels such as can be produced by direct combustion, and through the production of fuel pellets. Some types of biomass (eg forest wood) are valuable raw materials that can be used in many sectors of the economy. But waste recycling can be used to produce energy, but when transporting over long distances the cost of such fuel is growing, so it is granulated. However, in the processing of biomass into biofuel artificial costs increase. Varies and energy value of different types of biofuels.

Analysis of recent research. In [2; 3; 4] investigated the effectiveness of the use of solid biofuels in Ukraine during the period from 2010 to 2012. However, in the current year due to the difficult political situation in our country, prices for basic energy increased significantly.

Therefore, **the aim of our research** is to adjust the effectiveness of biofuels in the current year.

The results of research. Wood as fuel is highly environmentally friendly because it contains little sulfur. Specially harvested in the forest fuelwood, which is usually sold to the population in the form of firewood for about 150 USD/ meter warehouse, can also be used for heating of industrial and cultural facilities farms in boilers with a ball gasification furnace or boiler. Thus the cost of the energy obtained is 31,8 UAH/ GJ (Table. 1), which is comparable to the cost of thermal energy for heating with natural gas with a small amount of its consumption. Close to the cost of energy derived from the combustion of wood chips in thermal power plants.

When placing the farm woodworking shops heat can be produced from wood waste - sawdust, shavings, etc. by burning them in the vortex furnace or fluidized bed combustion of fuel. Thus the cost of the resulting thermal energy is about 11 USD/ GJ (see Table. 1), which is much less than the cost of thermal energy derived from burning natural gas. However, their transport over long distances is impractical

because of the low bulk density, which leads to an increase in transportation costs. The same applies to waste timber (tops, branches, twigs) that can be processed into fuel chips followed by combustion in vortex and retort furnaces or in fluidized bed combustion of fuel

Table 1

Cost parameters of biomass for energy use Ukraine

Kind of biomass	Bulk density kg/m ³	Price, UAH.	Calorific value, MJ/kg	The cost of 1 GJ of heat UAH
1	2	3	4	5
Sawdust (W=45%)	400	40 UAH/m ³	9	11,1
Wood chips from waste (W=15%)	220	120 UAH/m ³	15,7	34,7
Firewood oak suhie (W=15%)	300	150 UAH/m ³	15,7	31,8
Wood pellets are first class	-	1400 UAH/t	17	82,4
Straw bale (W=14%)	-	450-600 UAH/t	14,5	29,2-38,9
Pellets from straw	-	1000 UAH/t	15,5	64,5
Sunflower husk	-	180 UAH/t	15,4	11,7
Pellets made from the husks of sunflower	-	1000 UAH/t	15,4	65,0

For agricultural waste is the straw that remains in the field after harvesting crops and which can be used for energy purposes. Currently, due to the scarcity and high cost of gas demand for straw increased significantly, and consequently increased its value (straw bale weighing 20 kg is from 9 to 12 USD). In this regard, the cost of 1 GJ of heat produced by the combustion of straw bales, increased significantly compared to previous years and is 29,2-38,9 UAH/GJ.

Another most common in Ukraine is agricultural waste sunflower husks, the energy from the combustion of which is close to the energy of burning waste wood and is 11,7 UAH/GJ.

The promises more effective of the use of wood waste, sunflower husks, straw, etc. increases significantly in the case of their processing into fuel pellets that can not only burn for heating industrial and cultural facilities, but also profitable to sell, because the cost of fuel pellets in Ukraine reached 1,4 USD /t. In this case, due to their high cost due to the use of expensive equipment and a lot of energy to seal the energy cost of the granulated biofuel is also high and amounts to 65-82 UAH/GJ.

It should be noted that the pellets can be burned in retort furnaces automatic boilers or furnaces specially retrofitted ball. To date, however widespread they have not yet received. However, the high demand pellets used in the EU, where mainly exported and pellets produced in Ukraine.

With respect to energy derived from conventional fuels. In Ukraine, as a fuel for energy used mainly natural gas and coal. In our country, the use of these fuels

population subsidized by the state. To reduce the burden on the budget decision gradual increase in natural gas prices. The cost of natural gas burning from 1 May 2014 is shown in Table. 2, from which it is seen that at low amounts of natural gas, the cost of heat energy generated by combustion is comparable with the cost of thermal energy generated by combustion of baled straw, firewood, wood chips. When high annual use of natural gas at its price heat energy may be compared with combustion of fuel pellets.

Table 2
The cost of natural gas for Ukraine's population to 05/01/2014, the [5].

Provided that the amount of natural gas does not exceed	Price, UAH/m ³	Calorific value, MJ/m ³	Cost 1 GJ of heat, UAH
2500 m ³ /year	1,089	34	32,0
6000 m ³ /year	1,788	34	52,6
более 6000 m ³ /year	3,645	34	107,2

At the same time, the price of natural gas, which Ukraine receives reversal of Slovakia, is \$ 340 per 1000 m³, which is equivalent to the cost of a unit of heat energy obtained by burning it, is 130 UAH/GJ.

Coal in Ukraine in 2014 and sold to the population at thermal power plants at an average price of 662,6 USD/t [6]. When the heat value of coal 27 MJ/kg, the cost of energy for the population, obtained by burning it, is 24,5 UAH/GJ, which is lower than the price of energy derived from the combustion of natural gas in small quantities, firewood, fuel wood chips, straw bales and rolls.

However, coal is sold to the population in Ukraine at a price that is lower than its cost (of 1452 UAH/t [6]). Therefore, the real costs of energy derived from the burning of coal extracted in Ukraine is 53,8 UAH/GJ, which is slightly higher than the energy produced by burning wood chip fuel and baled straw, but less than the cost of energy pellets.

Findings

Wastes (sawdust, straw, chaff, etc.) due to their low cost advantageously used as fuel on site for their production, whereas in transportation increases their cost due to the high transportation cost. Energy efficiency wood chip fuel, baled straw with comparable efficiency natural gas using its minor amounts. Energy efficiency granular fuel due to high cost of sealing is comparable to the use of natural gas efficiency when using large volumes. However, in the pellets are in great demand, especially in the EU, so their production is quite attractive from a commercial point of view.

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USE AS A COSUBSTRATE FOOSE IN BIOGAS PRODUCTION

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Abstract: The advantages and disadvantages of using as a cosubstrate of crude glycerol. As a departure from the production of vegetable oil - fuzzi - there are more common raw materials in Ukraine, it is proposed to use it as a cosubstrate with pus methane fermentation of cattle. Comparative studies of biogas yield when used as a cosubstrate of crude glycerol and fuzzi

Keywords: biogas, crude glycerin, fuzzi, cattle manure, digester, biogas plant, cosubstrate.

Introduction. The main substrate for biogas production are animal wastes (manure of cattle, pigs, poultry, etc.), which, however, is characterized by relatively low productivity biogas. Biogas yield with the full cycle of fermentation of cattle manure 117 days is 237 L/kg, or 315 L/kg OWLs. [1]. That is, on average, during the day is roughly 2 liters of biogas from 1 kg of substrate, or 2,7 liters of biogas from 1 kg OWLs substrate. However, in practice, due to the low yield of biogas full cycle of methane fermentation do not adhere. The yield of biogas in the first 10-20 days of fermentation is 5,7 L/kg, or 7,6 L/kg OWLs.

With this performance 90-93% of biogas in the autumn-winter-spring period and 64-83% in the summer when mesophilic (temperature fermentation – 40°C) is spent on maintaining the heat balance of the concrete digester volume of 100 m³, insulation sheets thick mineral wool 60 cm.

Therefore, a significant problem biogas plants, which are used as a substrate waste from farm animals, is the low productivity of biogas, which leads to their low profitability. To improve the performance of biogas plants presently accepted use gradual loading process in which the reactor after the maximum biogas generating substrate is fed in small portions during the day, which leads to the conservation of the maximum biogas production over time. Also frequently added to the manure substrates which have a significant yield of biogas (800-1000 L/kg and more OWLs) grass, silage corn and beet tops, and other serum. However, these substrates have feed and nutritional value, so their massive use could lead to a reduction in the production of feed and food security.

So the problem of determining economy additives livestock manure (cosubstrate), which could substantially increase the biogas yield, and hence increase profitability of biogas.

Analysis of recent research. To increase the efficiency of biogas production as a cosubstrate, you can use the waste from biodiesel production – crude glycerol, with utilization of which the biodiesel production problems. It is recommended to add it to the main substrate, cattle manure which is in the range of 6,5-7% by weight of the manure in the substrate, which leads to an increase of 5-7 times the maximum yield of biogas [2; 3; 4].

Lack of a way to improve the performance of biogas production due to use as a

cosubstrate of crude glycerol is its limited resource. The yield of the crude glycerol from biodiesel production with rapeseed oil is about 20%. In Ukraine, according to the Ministry of Agrarian Policy, currently built 42 biodiesel plants and factories, which at full load can produce 500 thousand tonnes of biodiesel per year. In the farms of Ukraine is made from 50 to 70 thousand tonnes of biodiesel per year [5]. So, every year you can get about 110-114 thousand tonnes of crude glycerol as waste biodiesel production. The annual capacity of cattle manure as feedstock for biogas production is about 15,5 million tonnes [6]. In case of intensive construction of biogas plants in Ukraine and full using cattle manure as feedstock for biogas production, 7% crude glycerin supplements to the substrate for biogas yield intensification would last only 10% of the potential of the substrate.

Therefore, **the aim of our research** is to determine such a cosubstrate for methane fermentation of cattle manure, which would not be a value to the national economy or belonged to the category of waste, has been extended to the territory of Ukraine and allowed to increase the yield of biogas is similar to the crude glycerol.

The results of research. As a cosubstrate for biogas production can be used vegetable oil residue – fuzz (precipitate which formed in vegetable oils after removal of the raw fat).

In Ukraine in 2014 produced 4,67 million tons of sunflower oil, 129 thousand tons of soybean oil and 48 thousand tons rapeseed oil [7]. 1 tons of oil falls 200 kg fuzz [8]. That is, each year can receive about 1,38 million tons fuzz. With the full use of all produced in Ukraine fuzz as an additive to the substrate based on cattle manure, it is enough to increase the yield of biogas from 90% of the potential of the substrate.

A comparative study of biogas yield from the substrate with the addition of fuzz, crude glycerol and without additives were carried out on the biogas plant in teaching and research laboratories bioconversions in AIC National University of Life and Environmental Sciences of Ukraine.

The structure consists of a biogas plant digester gas tank I and II (Fig. 1). Digester I consists of an outer 1 and inner housings 2, which is placed between the water jacket 3 is filled with water through the tube 9 and serves to transfer heat from the heater to the substrate 20, which is contained in the core 4 of the digester, and acts as a thermal insulator core digester from the external environment. The water temperature is maintained by using an electric heater 20 and a temperature control system process. The water in the water jacket is filled through the tube 10 and the valve 16. To create a seal core digester 4, on top of it is covered with a lid 5 with a seal.

Through the tube 6 into the core 4 is filled with bioreactor substrate in semisolid form. The tube 6 reaches almost to the bottom of the digester core 4, so the fresh substrate is fed into the bottom of the reactor core, thereby displacing the fermented substrate (biosludge) through pipe 7. Immutability methane-complex microflora bacteria in the digester filling it must leave at least 1/3 biosludge, which will enable the rapid growth of microorganisms. To drain all biosludge for maintenance digester serves pipe 8. Integrity bioreactor provide valves 16.

In the digester when creating the optimal pH and temperature and in the absence

of oxygen occurs methane fermentation, during which formed biosludge, which is a valuable organic fertilizer and biogas released. To prevent skin formation and to ensure uniformity of biomass applied stirrer 19 which mixes the biomass periodically in the reactor core.

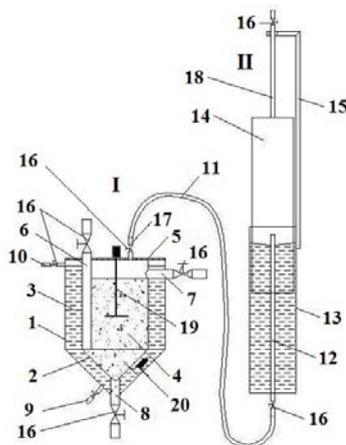


Fig. 1. Schematic diagram of the experimental biogas plant [9]: a – concept; 6 – general view; I – digester; II – gas tank; 1 – outer casing digester; 2 – inner housing digester; 3 – water jacket; 4 – active zone of the digester; 5 – cover; 6 – pipe for supplying biomass; 7 – pipe to drain biosludge; 8 – pipe to remove biosludge; 9 – water supply pipe; 10 – pipe to establish the level of water in the water jacket; 11 – pipeline; 12 – tube for feeding biogas; 13 – housing the gas tank; 14 – cylinder transmitter; 15 – guide; 16 – tap; 17 – pipe to carry the biogas digester from the core; 18 pipe for the selection of biogas from the gas tank; 19 – mixer; 20 – heater

Biogas from the digester through a pipe 17 to the pipeline 11 and further through the pipe 12 enters the gas tank II, wherein and stored. This setting is used "wet" gasholder, which consists of two cylindrical tanks: the housing 13 and the cylinder 14 gauge, as well as the guide 15. The body 13 of the gas tank is filled with water, which floats like a cork hollow cylinder-transmitter 14. The biogas through a tube 12 enters the inner cavity of the cylinder, the transmitter 14, which as biogas filling the guide body 15 rises over the gas holder, which enables to determine the presence and amount of gas in the gasholder II. From the gasholder biogas is given through a tube 18 through the valve 16 by squeezing the mass of the cylinder 14 gauge [9].

When conducting experimental research laboratory digester total volume of 29 liters partially filled cattle manure (filled digester volume – 15 liters). Thus digester filling ratio is $15/29=0,5$. To save a digester methane-stock culture of bacteria when loading substrate is not fully updated. Loading 3,75 liters of substrate which is made by mixing 1,5 kg of cattle manure in 2,25 liters of water with the addition of 50 ml of co-substrate.

In the bioreactor methane fermentation takes place, which releases biogas, which accumulates in the gasholder II. After contact with biogas gas tank, it raises the upper cylinder-transmitter 14, whose height is fixed daily on the scale attached to the guide of the gas tank. With the known diameter of the cylinder-gauge (20 cm) is determined by

the amount of dedicated biogas. Knowing the previous and the current lock the lift cylinder, gas tank gauge is determined hourly output of biogas.

Comparative analysis of the biogas outlet from the substrate by adding fuzz, crude glycerol and no added cosubstrate shown in Fig. 2.

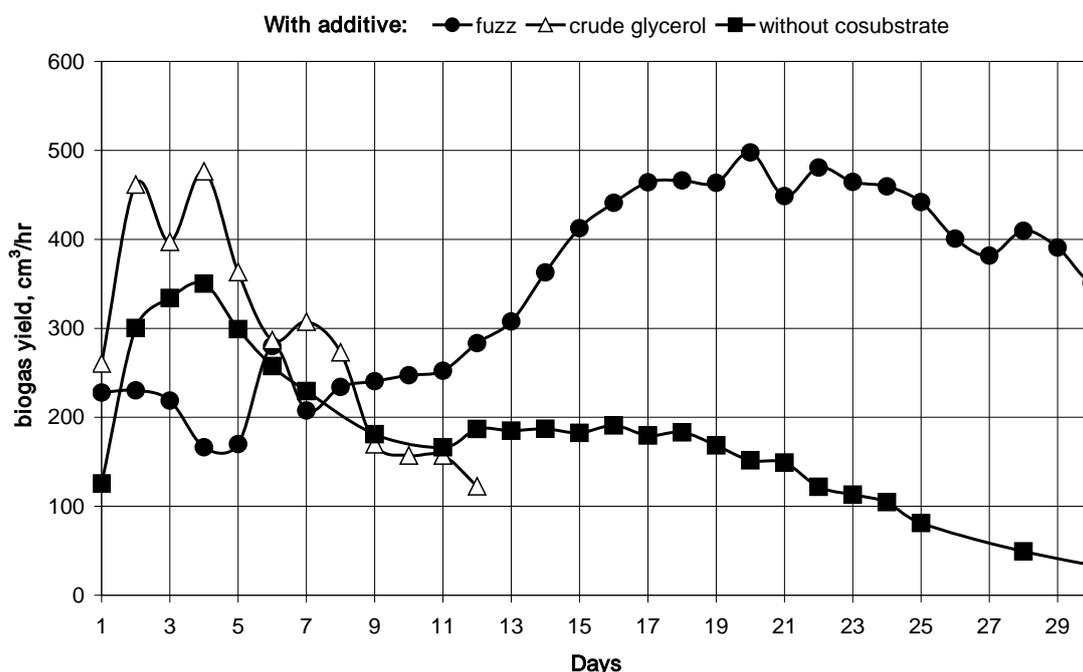


Fig. 2. Comparative analysis of intensification of biogas yield based on the substrate with cattle manure is used as the additives and fuzz crude glycerol (11,7% of cattle manure) and without their use in a batch process downloads

As can be seen from Fig. 2, the yield of biogas in a batch process using a load and as an additive to the substrate on the basis of cattle manure fuzz identical to adding the same substrate crude glycerol, and 2,5 times higher than the yield of biogas from the substrate without the use of additives. With the gradual method of loading the substrate biogas yield, analogous to the use of raw glycerol as an additive to the substrate, can grow in 4,5-10 times.

Findings. Using fuzz as co-substrate will increase the biogas yield by 2,5 times when a batch process, the substrate loading and 4,5-10 times – while gradually. Thus a spread materials fuzz compared with crude glycerol. With the full use of all produced in Ukraine fuzz as an additive to the substrate based on cattle manure it is enough to increase the yield of 90% biogas produced in Ukraine cattle manure.

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J11510-041

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**CHANGES OF QUALITY AND BIOLOGICAL VALUE OF
FERMENTED CUCUMBERS AFTER PROLONGED STORAGE**

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The results of studies changes in the quality and biological value of fermented cucumbers depending on the duration of storage are article presents.

Key words: cucumber, chemical composition, fermentation, storage, quality.

Introduction. Preparation of fermented vegetables, such as cucumbers salted in the winter, carried out in industrial scale and among the population in Ukraine [7,10].

Their preparation is based on the addition of salt and natural accumulating of natural preservative - lactic acid. Fermented cucumbers combine with many dishes are very universal. Due to the presence of natural organic acids and salt stimulate the appetite. The content of lactic acid in them to 0.6-1.4% inhibits the proliferation of *Escherichia coli* and other more dangerous microorganisms. People controlling their weight should take on a note that calorie fermented cucumber less than 13 kcalory.

Indicators of the nutritional value are not high, but due to the high assimilability of the components, are very valuable, for example: proteins - 0.8 g, carbohydrates - 1.7, dietary fiber - 0.8, organic acids - 0.7, water - 92 and starch - 0.1 g

Among the macronutrients sodium prevails, but there are others: Calcium - 23 mg, magnesium - 14, sodium - more than 1,000, potassium - 141, phosphorus - 24 mg, and among trace elements found only iron - 0.6 mg per 100 g of product. Vitamin composition is varied, it is important to note that they are natural and easy to assimilate, example: vitamin PP - 0.1 mg, β -carotene - 0.03, B₁ - 0.02, B₂ - 0.02, B₃ - 0.2, B₆ - 0.03, Vitamin C - 8.5, E - 0.1 mg, PP - 0.2, B₉ - 3 mg, A - 5 mkg per 100 g of product. The use of high-quality fermented cucumbers will diversify the ration and provide the human body with valuable and biologically active components in winter [1,2,3,6,7].

The purpose of research. The aim of our study was to investigate the chemical composition and quality of fermented cucumbers, depending on the duration of storage.

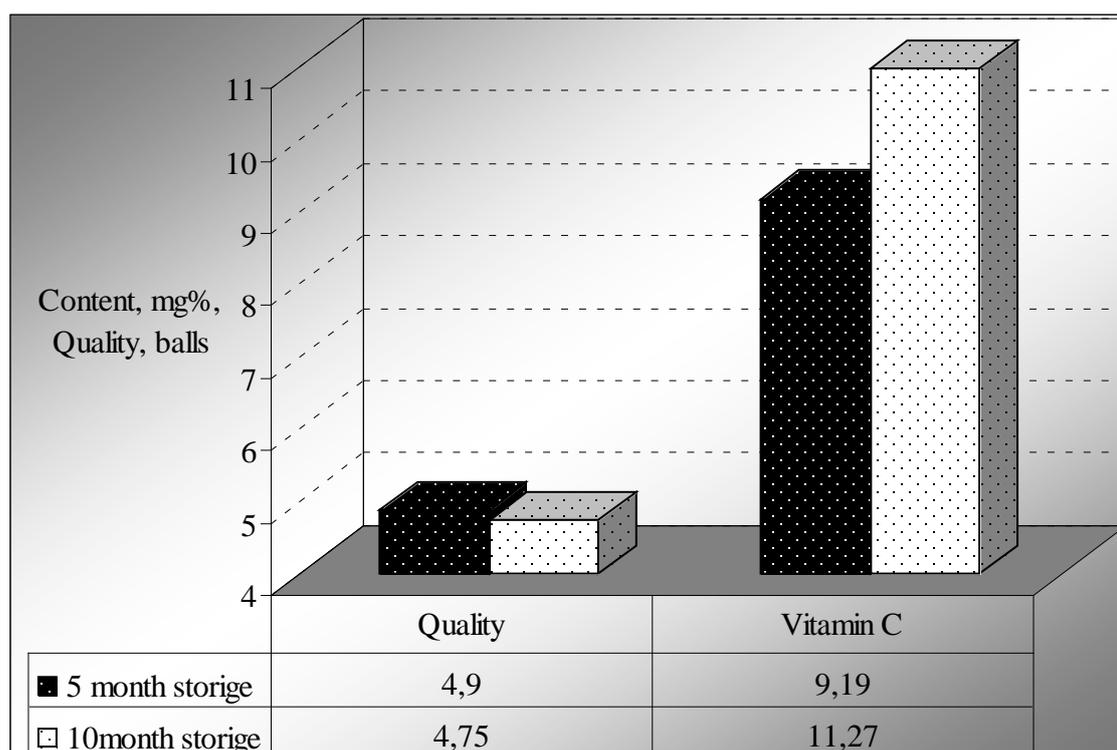
Place of the, objects and methods of research. Investigations were carried out at the Department of storage technology, processing and product standardization of plant products after prof. B.V. Lesika National University of Life and Environmental Sciences of Ukraine. The objects of study were the fruits of cucumber sort Asterix (gherkins groups 1 and 2).

Organoleptic characteristics of fresh fruits gherkins were quite high. Brine take - 6 -7%. Spices: garlic - 20 g, horseradish leaves - 50 grams, dill - 13 Cherry - 9, tarragon - 3, currants - 15 g per 3-liter jar. For processing small batches were using 3

dm³ glass jars. Technology of preparation of fermented cucumbers is traditional raw materials preparation, spices fills. On the bottom half of the jars were placed spice, and the second part of currant and horseradish, were stacked on top. The jars were closed with nylon cover. Banks were stored in the basement at a lower temperature + 10 ... + 12 ° C (August-September) and winter-spring period + 4 ... + 6 C. Experiments laid in 4-6 repeats. Raw materials grown in the Kiev region. The chemical composition, the quality of fresh processed products were determined by standard methods [4,9].

Results and discussion. Fermented products after storage for 5 months reached the highest quality (Fig. 1). Analyzing the data obtained it should be noted that the weight of gherkins of the first group was by 3-9% higher in 3 liter tank gherkins, than the second group. Comparing the indicators of quality of fruits of different storage periods (5 and 10 months) observed a slight decrease in the quality, in particular indicators crunch, texture (softening of the fruit) and a slight change in appearance.

We fixed the increase in concentration of soluble solids of the finished product after 10 months of storage (7-16%), due to the adsorption of solids fill and spices (carbohydrates, organic acids, vitamins, etc.).



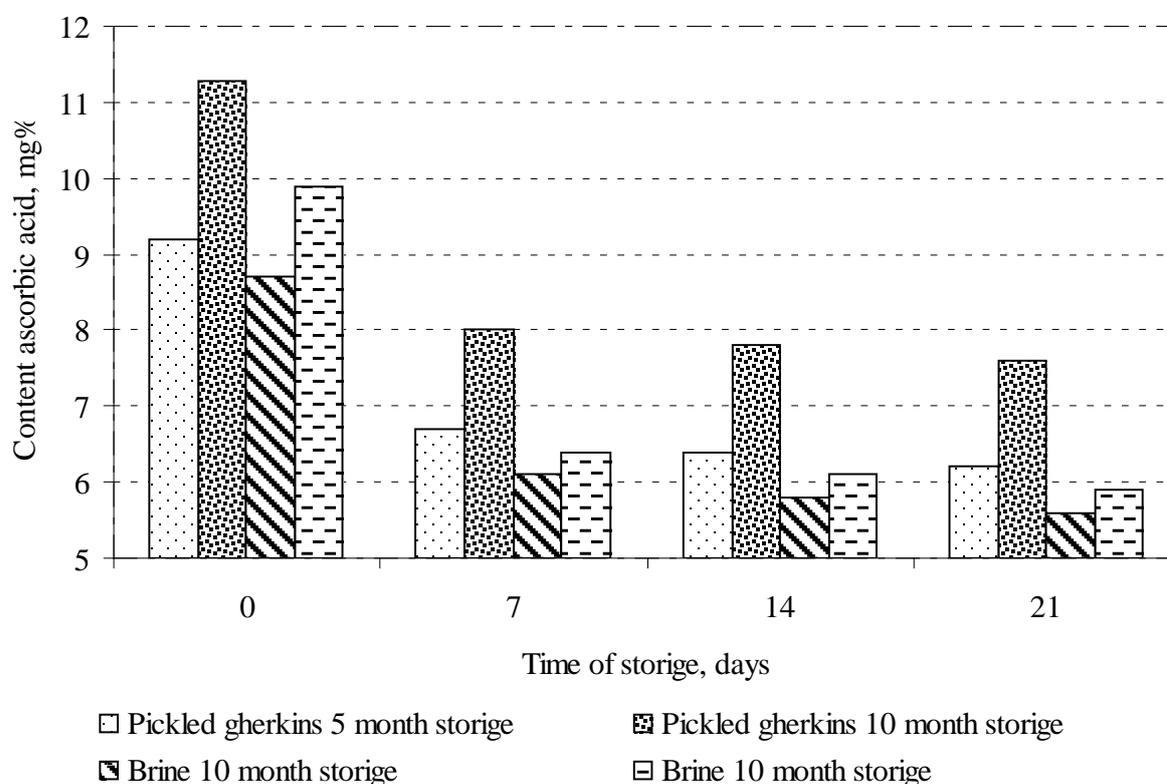
Paint. 1. Effect of storage duration on the quality and concentration of ascorbic acid in pickles

Biological value of the fermented products was evaluated for the change in concentration of ascorbic acid. Interesting to work the increase in the concentration of vitamin C for longer periods (10-33%), which is associated with a more complete extraction fill in with the leaves of horseradish, cherries and currants [5].

The concentration of organic acids after five months of storage was 0,74-0,76%, which is sufficient for the formation of a balanced taste and oppression pathogenic organisms. After 10 months of storage, the content increased to 1,06-1,08%, which does not substantially affect the taste balance, but positively - resistance to the finished product during storage [8].

Dispersion analysis of influence of quality raw materials (cucumber group) and duration of storage for the formation of quality and ascorbic acid concentrations showed that overall quality is more dependent on the storage time, rather than from a group of quality.

After the storage for ten months determined the vitamin C content in cucumbers and filling (brine). It was found that after the opening of banks concentration of ascorbic acid in 7 days decreased by 27-29%, and after 14 days - 2-3.5%, subsequent storage does not contribute to a significant loss of the substance (after 21 days still 2-3 %) (Fig. 2). It can be argued that after taking out of production brine is enriched with oxygen and rapidly oxidizes ascorbic acid.



Paint. 2. Effect of storage duration on the concentration of ascorbic acid in pickles and brine

Conclusions. Research has shown that after 5 and 10 months of storage fermented cucumbers have a sufficiently high quality. After ten months of storage of fermented cucumbers biological value is increased by 10-33%. After opening tank it is advisable to fermented cucumbers should be used for seven days. Storing opened jars in the refrigerator uncovered data obtained is reasonable to consider with storing cucumbers to provide consumers with qualitative and biologically valuable fermented products.

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**EFFECT OF STORAGE CONDITIONS ON QUALITY OF MUSHROOMS
CHAMPIGNON BISPORED AND OYSTER PLEUROTUS
DURING ITS STORAGE**

Results of study of influence of duration and storage conditions on biochemical indexes of industrial cultivated of mushrooms of champignon bisporoid and oyster pleurotus were presented.

Key words: mushrooms, champignon bisporoid, oyster pleurotus, conditions of storage, time of storage, biochemical indexes

Introduction. Statistical data UN Food and Agriculture indicate that the population of our planet's food is a major concern. The main problem is the lack of protein and its imbalance in the diet of people. In recent decades there has been a rapid increase in production and consumption of cultivated edible mushrooms in fresh and processed form [1, 2]. Scientists project that in the future, much of the necessary human proteins will be satisfied from the industrial production of edible mushrooms. Today in Europe and the CIS is one of the leading places among the cultivated mushrooms of champignon bisporoid and oyster pleurotus [3-5].

When storing mushrooms quickly lose their marketable quality and change their biochemical composition of substances, so they should be stored at low temperatures. The optimum storage temperature for mushrooms is within 0-2 °C. In practice, producers and retail chains often can not provide this mode. Therefore, the aim of our study was to determine the effect of different storage temperatures and duration of storage on the change in biochemical indexes champignon bisporoid and oyster pleurotus.

Materials and methods. Mushrooms designed to hold grown according to conventional technology by respective species and strain. In studies using mushrooms of champignon bisporoid of strain IBK-25 and oyster pleurotus of strain NK-35 from the collection of living plants higher edible mushrooms Institute of Botany. M.G. Xolodnogo NAS of Ukraine. These strains are widespread, highly suitable for growing all year round and for general purposes.

Studies of storage mushrooms of champignon bisporoid and oyster pleurotus carried out by "Methodology of research affairs in Vegetables and Melons" [6] and according to developed and approved for official use scientific and technical council of Kiev Experimental Station of the Institute of Vegetables and Melons NAAS of Ukraine "Research Methodology research on storage mushrooms" (2001).

Mushrooms stored at four cold chamber KX-610 with a working volume was 6 m³ which equipped electric lighting and appliance control temperature and humidity.

Storage temperature mushrooms are minus 1, 1, 3 and 5 °C. Repeated was four times. Relative humidity in storage chambers was 90 ± 1%. Control was a product which was kept at a temperature of 1 °C. Mushrooms stored for 6 days.

Quality of fruit bodies of mushrooms before storage and after its completion was performed biochemical analysis of on the content:

- Dry substance – thermostat-weight method by drying to constant weight at a temperature of 105 °C (GOST 28562-90);
- Protein nitrogen – for Barshteynom;
- Vitamin C – for Murray, GOST 24556-89.

Results. Based on the literature review and performed our previous studies for the research it was found maximum shelf mushrooms, which provided them with appropriate quality 6-day storage temperature were minus 1, 1, 3, 5 °C.

Temperature of storage is minus 1 °C all the fruiting bodies of mushrooms champignon bispored partially or completely frozen. Obviously, this is due to the high moisture content (90-93%) and low content of sugar (about 2%). The structure of tissue destroyed and not recovered after thawing products. Fruit bodies were dark, slippery and soft (fig.1). These mushrooms are not suitable for sale and therefore this temperature storage was rejected, as it did not provide good quality products, and research on changes in biochemical parameters mushrooms of champignon bispored at this temperature was not performed.

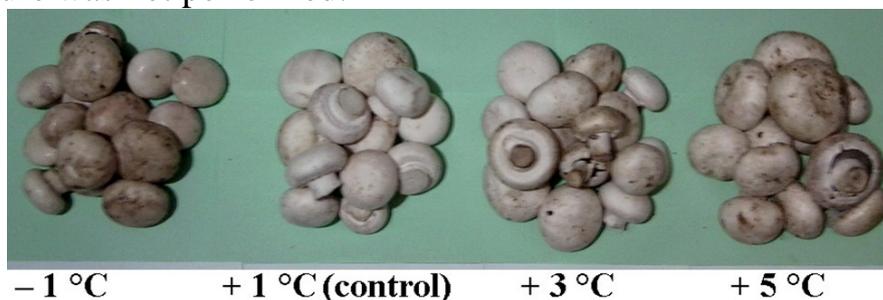


Fig. 1. Fruiting bodies of mushrooms champignon bispored of strain IBK-25 after storage during 6 days at the different temperatures

Temperature keeping of oyster pleurotus minus 1 °C carried out to their partial freezing. After thawing of fruiting bodies lose marketable quality but their flavor properties and structure is not completely lost (fig. 2), obviously due to the high content of dry substance (9,4-10,3%), chitin and cell structure. Thus, although these mushrooms are not suitable for implementation in fresh, but can be used for processing, so the study of biochemical changes compared to the storage temperature minus 1 °C for oyster mushroom spent.

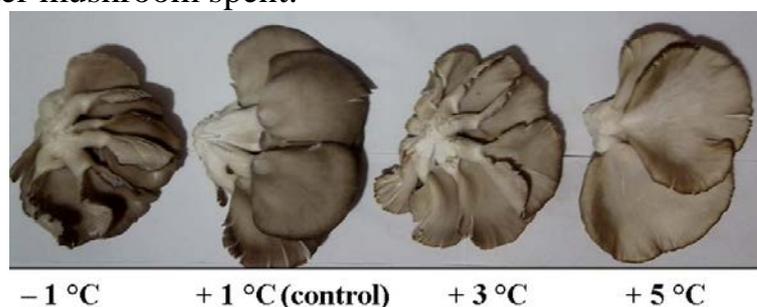


Fig. 2. Fruiting bodies of mushrooms oyster pleurotus of strain NK-35 after storage during 6 days at the different temperatures

Storing mushrooms champignon bispored and oyster pleurotus some changes in their biochemical composition (Table 1-2). The results indicate that the reduced quantity of dry matter and vitamin C decreases or does not change the number of protein nitrogen.

Thus, in the fruit bodies of champignon bisporoid first wave fruiting 1 ° C of dry matter at the beginning of storage was 9.4% and in the end - 8.9%, the amount of ascorbic acid - 5.6 and 5.1 mg%, respectively. Number protein nitrogen remained unchanged and equal 3.0%. In the same conditions in mushroom of oyster pleurotus dry matter changed from 10.3 to 9.5%, the content of ascorbic acid - from 9.8 to 9.0 mg% and protein nitrogen remained unchanged (3.0%).

Table 1

**Content biochemical substances in the fruit bodies of mushrooms
champignon bisporoid of the strain IBK-25**

Temperature storage, °C	Biochemical substances					
	dry substance, %		protein nitrogen, %		ascorbic acid, mg%	
	beginning storage	end storage	beginning storage	end storage	beginning storage	end storage
The first wave of fruiting						
1 (control)	9,4	8,9	3,0	3,0	5,6	5,1
3	9,4	8,5	3,0	3,0	5,6	4,9
5	9,4	8,0	3,0	2,8	5,6	4,5
The second wave of fruiting						
1 (control)	8,6	7,8	2,9	2,9	5,4	5,0
3	8,6	7,4	2,9	2,8	5,4	4,4
5	8,6	7,1	2,9	2,7	5,4	4,0

Table 2

**Content biochemical substances in the fruit bodies of mushrooms oyster
pleurotus of strain NK-35**

Temperature storage, °C	Biochemical substances					
	dry substance, %		protein nitrogen, %		ascorbic acid, mg%	
	beginning storage	end storage	beginning storage	end storage	beginning storage	end storage
The first wave of fruiting						
-1	10,3	9,3	3,0	2,9	9,8	9,4
1 (control)	10,3	9,5	3,0	3,0	9,8	9,0
3	10,3	9,4	3,0	3,0	9,8	8,7
5	10,3	9,0	3,0	2,8	9,8	8,4
The second wave of fruiting						
-1	9,4	8,8	2,8	2,7	9,6	8,8
1 (control)	9,4	8,5	2,8	2,8	9,6	8,5
3	9,4	8,3	2,8	2,7	9,6	8,0
5	9,4	7,7	2,8	2,6	9,6	7,6

Regularities of changes in biochemical parameters for the second wave of fruiting champignon bisporoid and oyster pleurotus during storage at a temperature of 1 ° C had the same trend as the first. Feature biochemical parameters mushroom fruiting second wave were smaller quantities of dry matter and vitamin C at the beginning of storage, resulting in their lower values at the end. This can be explained by a decrease in nutrient substrate for mushroom fruiting period of the first wave.

With increasing temperature storage was an increase in losses of dry matter, protein nitrogen and vitamin C.

Thus, the storage of mushrooms of champignon bispored first wave fruiting at 5 °C of dry matter decreased from 9.4 to 8.0%, vitamin C - from 5.6 to 4.5 mg% and protein nitrogen - from 3.0 to 2.9%.

In the mushroom of oyster pleurotus at the same temperature also increased loss of dry matter from 10.3 to 9.0%, vitamin C from 9.8 to 8.4 mg% and protein nitrogen from 3.0 to 2.8%.

Changes of biochemical parameters for the second wave of fruiting mushrooms of champignon bispored and oyster pleurotus during storage at 5 °C had the same trend as the first, but had lower absolute values, as grown on depleted compost.

Separately should analyze the changes in the biochemical composition of oyster pleurotus when it stored at a temperature of minus 1 °C. Due to the partial freeze fruiting bodies of mushrooms after thawing lost dry matter on 0.2 % more compared with storage at a temperature of 1 °C (control). However, this temperature promoted a better preservation dry matter than storage at 5 °C, where losses were 0.5% higher compared to the control. Ascorbic acid at this temperature coincides best. The maximum difference of vitamin losses between the better variant (keeping the temperature minus 1 °C) and the worst variant (storage at a temperature of 5 °C) was 1 mg%. Protein, which is the most stable indicator during storage at different temperatures varied from 3.0 to 2.8%. Thus, keeping the temperature minus 1 °C provides better preservation of biochemical parameters than temperature 3 and 5 °C.

Conclusions

1. Analysis of the effect of different storage temperatures on the stability of biochemical composition of mushrooms showed that the best storage temperature, which ensures the safety of biochemical parameters mushrooms champignon bispored and oyster pleurotus was 1 °C.

2. Temperature of storage minus 1 °C was not suitable for mushrooms of champignon bispored as contributes to loss of product quality. Storage at the same temperature mushroom of oyster pleurotus carried out only to a partial loss of marketability and biochemical parameters remained stable.

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УДК 669.2

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**ИЗВЛЕЧЕНИЕ МЕТАЛЛОВ ИЗ ОТХОДОВ
МЕТАЛЛУРГИЧЕСКОГО ПРОИЗВОДСТВА***Белгородский государственный технологический
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**EXTRACTION OF METALS FROM WASTES OF METALLURGICAL
PRODUCTION***Belgorod State Techological University named after V.G.Shukhov,
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Аннотация. Проведены исследования по термическому восстановлению оксидов железа материалами-восстановителями. В качестве восстановителей использовали углеродсодержащие компоненты и алюминий. Определены условия восстановления.

Ключевые слова: углеродный восстановитель, алюминиевая пудра, оксиды железа, восстановление оксидов.

Abstract. Studies on the thermal reduction of iron oxide by using reducing agents have been carried out. Carbon-containing components and aluminum were used as reducing agent. The reduction conditions were determined.

Key words: carbon reducing agent, aluminum powder, iron oxides, the reduction of oxides.

Production of the ferrous and nonferrous metals is accompanied by the formation of a large amount of wastes, significant part of which are not used and are stored in the dumps and storage facilities. These wastes include metallurgical slag, products of gas purification, sewage sludge. Metal extraction from slag and dust is an important part of resource saving in metallurgical production, which allows returning the extracted metal in metallurgical cycle, getting high quality slag production, solving environmental and pollution problems due to the dusty metallurgical wastes.

Moreover, the depletion of raw material resources including non-ferrous metals could be prevented by developing new processes and equipment for processing of mineral resources and, what is especially important, it could be prevented by transition of industrial production to so-called "closed", "subsurface" flow charts [1 - 3].

One of the directions of recycling industrial wastes in order to produce quality steel products is the creation of technology for production of pure original charging material - direct reduced iron. To implement the reduction process it is necessary to break the intramolecular bonds. Such bonds are well studied quantitatively and they are reference values for some elements [4].

Depending on the type of the reducing agent, there are three main ways: carbon-reduction, silicothermic and aluminothermic. In practice, the most common technique of reduction is carbon reduction, when energy (395 kJ/mol), which is released during

oxidation of carbon, destroys the intramolecular bonds in the molecular species, which are within the "burning interval" of carbon.

In the scientific literature the reduction of oxides using carbon is usually called direct reduction, and reduction of carbon using oxides is called indirect or consequential reduction.

The possibility of direct interacting between carbon and solid oxide is limited due to the imperfect contact between the lumpy materials. Therefore, the direct reduction reaction proceeds predominantly with the gas phase. This reaction is the result of sequential reactions of indirect reduction (1).



and interreaction of carbon dioxide with carbon.



The result of sequential reactions (1) and (2) can be described by the equation (3)



According to the Hess' law (4)



Aluminothermic processes using aluminum powder are connected, primarily, with preparation of pure metals such as chromium, manganese, vanadium, zirconium, niobium, boron, and ferroalloys. It is important in industrial conditions to have sufficient heat for melting of the reaction products and separate the metal and slag during aluminothermic reduction, self-propagating on the entire charge, which consists of a mixture of aluminum powder and metal oxide. The slag, which floats up, protects the metal from reacting with the atmosphere.

The success of aluminothermic reaction depends on the particle size of the metal oxide and aluminum. It also depends on the composition of the mixture: the finer the powder, the more intense the reaction (5).



The authors carried out studies on the carbon and aluminothermic reduction of metal oxides from the dust and sewage sludge of metallurgical production.

The objects of study are dust of gas cleaning from electro arc steel furnaces, iron scale from rolling plant and sludge of water treatment of JSCo "Oskol Elektrometallurgical Plant". The aluminum powder was used as reducing agent – GOST 5494-95 "Aluminum powder. Technical conditions"; wood charcoal; coke JSCo "Gubakhinsk coke", (Gubakha, Perm Kray).

Specifications of objects of research are presented in Tables 1 – 4.

Table 1

The chemical composition of the dust of gas cleaning EASF (mass fraction, %)

CaO	Fe ₂ O ₃	SiO ₂	Na ₂ O	MgO	ZnO	Al ₂ O ₃	K ₂ O	MnO	SO ₃	Cl	PbO	Cr ₂ O ₃	CuO	P ₂ O ₅	TiO ₂	NiO	V ₂ O ₅
6,06	56,42	5,48	13,45	6,58	3,75	0,44	2,89	1,88	1,24	0,53	0,25	0,25	0,14	0,14	0,02	0,02	0,01

Table 2**The chemical composition of the sludge of water treatment (mass fraction, %)**

CaO	Fe ₂ O ₃	SiO ₂	Cr ₂ O ₃	SrO	ZnO	Al ₂ O ₃	K ₂ O	MnO	S _{sulfite}	CuO	NiO	P ₂ O ₅	TiO ₂	Org. sub.	H ₂ O
4,26	53,09	1,61	0,38	0,03	0,07	1,74	0,11	0,99	0,36	0,26	0,04	0,27	0,04	13,35	23,40

Table 3**The chemical composition of the iron scale (oily) from rolling plant (mass fraction, %)**

Fe ₂ O ₃	SiO ₂	Al ₂ O ₃	CaO	S _{sulfite} _e	P _{tot.}	Cr ₂ O ₃	CuO	NiO	MnO	Oil	Org. sub.
79,78	1,53	2,03	0,56	0,11	0,14	0,97	0,36	0,14	0,78	1,30	12,30

Table 4**The chemical composition of the coke (mass fraction, %)**

C	H	N	O	S
96,60	0,45	0,67	0,30	1,98

The reduction of metal oxides from iron-containing wastes using aluminothermy was performed with samples weighing 50 g.

For this purpose in accordance with reduction reaction (5) the stoichiometric amount of aluminum powder was determined. Waste and reducing agent were thoroughly mixed and the resulting mixture was heated in a muffle furnace at atmospheric pressure to determine the temperature at which the exothermic reduction reaction starts.

Because of reaction, an intensive oxidation of aluminum occurs due to the oxygen, which is contained in the oxides of iron and other metals. The process is accompanied by high heat release, for example, the reduction of iron releases 3560 kJ / kg, which provides rapid heating of the mixture to the melting point of metals and formation of the slugs. [5,6].

Changes in the residual content of metal oxides in mixture of aluminum and dust EASF (dust) depending on the preheat temperature in a muffle furnace are shown in Table 5.

The table shows that the content of iron oxides decreased by more than 16 times compared to the initial content. There is also the reduction in heavy metal oxides content. This is due to the oxides reduction and formation of metal ingot. An increase in content of aluminum oxide in the residual slag is connected with the process of aluminothermy. An increase in content of silicon oxides, calcium and magnesium can be explained by the transition from the material of crucible. Figure 1 shows metal

ingots, which are obtained by method of aluminothermy. Table 6 shows the chemical composition of ingot.

Table 5
Changes in the residual content of metal oxides depending on the heating temperature

Heating temperature, °C	Metal oxides content									
	Al ₂ O ₃	Fe ₃ O ₄	CaO	SiO ₂	ZnO	MgO	MnO	PbO	Cr ₂ O ₃	CuO
500	51.65	23.76	6.80	3.90	2.55	1.57	1.04	0.19	0.25	0.12
550	51.32	23.81	6.51	3.93	2.55	1.55	1.07	0.19	0.20	0.10
570	51.71	4.97	15.77	11.16	0.39	3.79	1.86	0.01	0.14	0.09
590	53.51	2.94	16.25	11.47	0.06	4.25	2.17	0.03	0.14	0.08

Table 6
The chemical composition of ingot (mass fraction, %)

Fe	Al	Si	Mn	Cr	Mg	Cu	P
90,3	3,2	3,4	1,6	0,5	0,3	0,2	0,1



Fig. 1. Metal ingots obtained by method of aluminothermy from dust EASF a) at the bottom of crucible; b) after grinding

To study the reduction of oxides of metals from the sludge from sedimentation basin and scale from rolling plant using carbon the samples were prepared as follows. The crushed coke or charcoal was putted at the bottom of corundum crucible and it was covered with a layer of scale or dried sludge. The layer of coal was putted on the top. The crucible was covered with a lid and placed in the muffle furnace. The thermal treatment was performed at a temperature of 1350 °C and the dwell time at the maximum temperature for 90 minutes. The resulting metal ingots are shown in Figures 2 - 4. Tables 7 and 8 show the chemical compositions of ingots at a carbon reduction.

Table 7
The chemical composition of the ingot obtained from the sludge using charcoal (mass fraction, %)

Fe	Al	Si	Mn	Cr	Mg	Cu	Ag
85,1	0,2	0,3	2,8	0,5	0,2	0,2	0,3



Fig. 2. The metal reduced from the sludge using charcoal



Fig. 3. Ingot metal obtained by heating the scale with coke



Fig. 3. Ingot metal obtained by heating the scale with charcoal

Table 8

The chemical composition of the ingot obtained by heating the scale with coal coke (mass fraction, %)

Fe	Al	Si	Mn	Cr	Mg	Cu	Ag
88,6	0,1	0,6	0,7	0,8	0,2	0,1	0,1

The results of experiments showed that the process of aluminothermic reduction of metal oxides starts by heating a mixture of waste and aluminum to 570 - 590 °C in accordance with the chemical reaction (6) with heat release and heating of the material to the melting point of metals.



The result is metal ingots, which are easily separated from the non-metallic part. The efficiency of reduction process depends upon how thoroughly the mixture is stirred. The reduction of oxides is more intense after preliminary mechanical activation.

The greatest effect during carbon reduction is achieved at a temperature not lower than 1350 °C. When the layered heat treatment is performed, there is a separation between metal ingots and spent carbon material. Re-oxidation of the

reduced metal is excluded due to the additional layer of carbon reducing agent, which is over the layer of the processed material. [7]. When coke and charcoal are used as reducing agents, there are no differences in the composition of the resulting ingots.

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Лагойда А.И., Семенцов Г.Н.

**РОЗРОБКА ШВИДКОДІЮЧОГО БАГАТОПАРАМЕТРИЧНОГО
КЕРУЮЧОГО ПРИСТРОЮ ДЛЯ АНТИПОМПАЖНОГО
РЕГУЛЮВАННЯ ГАЗОПЕРЕКАЧУВАЛЬНОГО АГРЕГАТУ**

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**DEVELOPMENT OF FAST-ACTING MULTIVARIABLE CONTROLLER
FOR ANTI-SURGE CONTROL OF GAS COMPRESSOR UNIT**

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Анотація. На основі функції передачі газоперекачувального агрегату розроблено структури ПІД-, ПІДД2-, ПІДД2Д3-, ПДД-, ПДД2-, ПДПД-регуляторів. Проведено обрахунок оптимальних параметрів налаштування та здійснено моделювання перехідних процесів в програмному продукті Matlab. Зроблено порівняльний аналіз перехідних процесів та вибрано оптимальний, який забезпечить максимальну швидкодію антипомпажного регулювання.

Ключові слова: відцентровий нагнітач, регулятор, налаштування, функція передачі, швидкодія.

Abstract. On the basis of the transfer function of gas compressor unit, the structures of PID-, PIDD2-, PIDD2D3-, PDD-, PDD2-, PDPD- controllers have been designed. Optimal settings were calculated and modeling of transient processes was performed in the software product Matlab. A comparative analysis of transient processes was carried out and the best process was chosen that would provide maximum performance of anti-surge control.

Keywords: centrifugal compressor, controller, adjustment, the transfer function, performance.

The system performance of anti-surge control of gas compressor units (GCU) is a key factor in improving the reliability of the compressor stations of underground gas storage facilities. However, this problem should be solved separately for each GCU, because the transfer functions of each of them differ by parameters. In this regard, it becomes important to consider the possibilities of determining the optimal transient process in real anti-surge control system of GCU [1].

The transfer function of the centrifugal blower (CB) GCU [2, 3]:

$$W(s) = \frac{7,688 \cdot 10^{-4} \cdot s + 0,619}{4,099 \cdot 10^{-5} \cdot s^2 + 1,526 \cdot 10^{-2} \cdot s + 1,358} \quad (1)$$

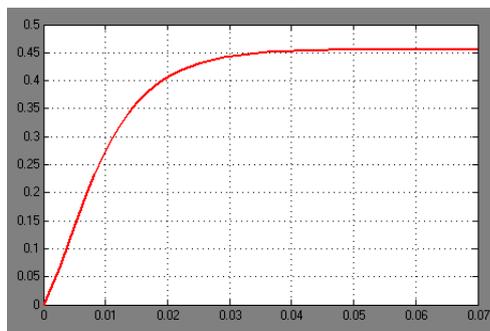


Fig. 1. The transient function of CB of GCU as an object of control

Controllers (PID, PIDD2, PIDD2D3) were created to find the optimal settings, the general structure of which is shown in Figure 2. To calculate the parameters an element of optimizer “Signal Constraint - Check Step Response Characteristics” was used from library Simulink. The results of modeling of transient processes with appropriate controllers are shown in Table 1.

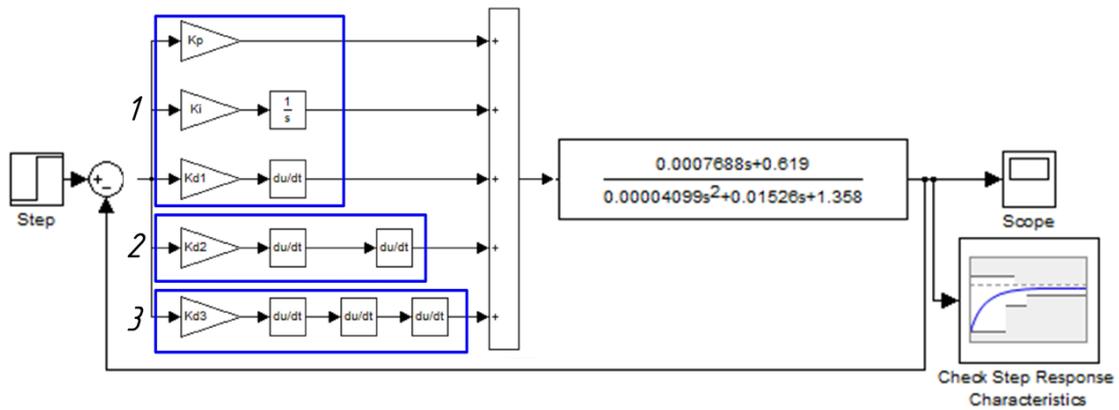


Fig. 2. The structure of PID(1), PIDD2(1+2), PIDD2D3 (1+2+3) controllers

Table 1

The settings of PID-PIDD2D3 controllers

Controller	Settings				
	K_p	K_i	K_{d1}	K_{d2}	K_{d3}
PID	29,7958	867,4924	0,0579	—	—
PIDD2	29,7958	830	0,0579	9,7480e-010	—
PIDD2D3	33,3	950	0,0528	5,9480e-009	3,7480e-022

As is known, the system performance will be greatest when the transfer function of the controller is the inverse of transfer function of object. Therefore, the transfer function of an ideal controller is [4]:

$$W_p(s) = \frac{4,099 \cdot 10^{-5} s^2 + 1,526 \cdot 10^{-2} s + 1,358}{7,688 \cdot 10^{-4} s + 0,619} \tag{2}$$

On the basis of the transfer function 2 PID-, PIDD2-, PDPD- controllers were designed (Fig. 3, 4, 5). The results of modeling of transient processes with appropriate controllers are shown in Table 2.

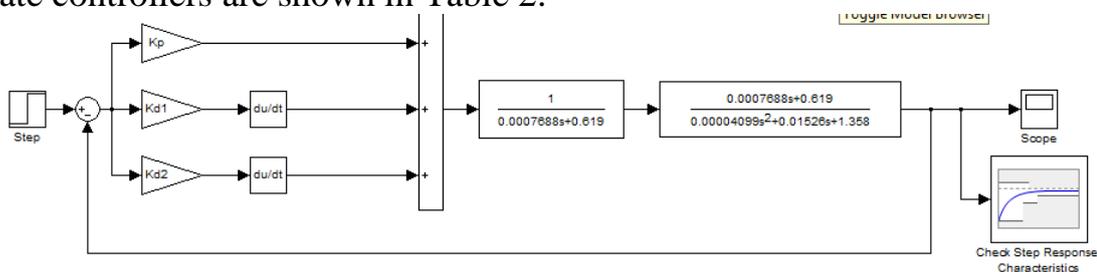


Fig. 3. The structure of PDD controller

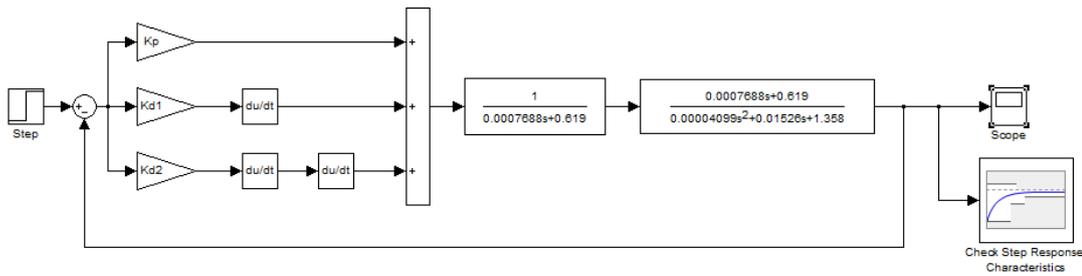


Fig. 4. The structure of PDD2 controller

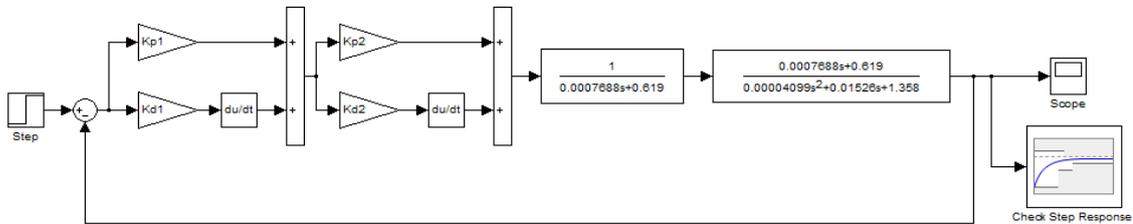


Fig. 5. The structure of PDPD controller

Table 2

Configuration settings of controllers after optimization

Controller	Settings			
	K_{p1}	K_{p2}	K_{d1}	K_{d2}
PDD	480,3580	-	0,0353	0,1699
PDD2	1,0324e+003	-	0,3311	6,5990e-006
PDPD	478	250	0,0065	0,0100

Referring to the Tables 1 and 2 and corresponding structures of controllers, we can form transient characteristics (Fig. 6).

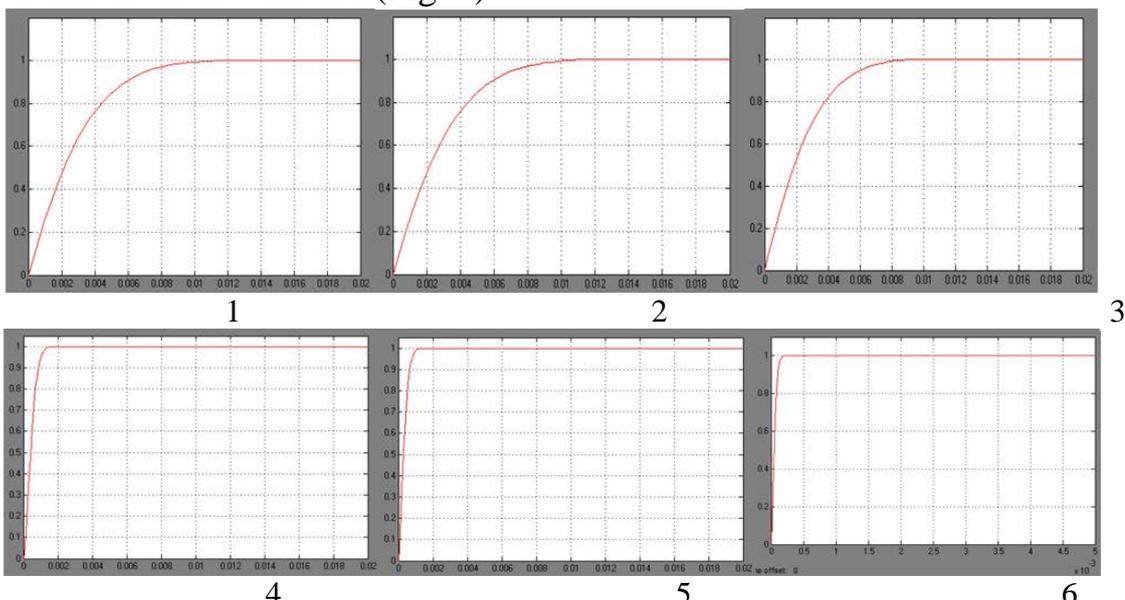


Fig. 6. The transient characteristics 1 - PID; 2 - PID2; 3 - PID2D3; 4 - PDD; 5 - PDD2; 6 – PDPD

Table 3 shows the indicators of quality of transient processes of controllers under study.

Table 3**The indicators of quality of transient processes**

Type of controller	Indicators of quality of transient process	
	acceleration time, s	deregulation, %
PID	0,01125	0
PIDD2	0,01075	0
3 PIDD2D	0,0087	0
PDD	0,0017	
PDD2	0,0012	0
PDPD	0,0002	0

The studies have shown that the optimal transient process, which was determined, in anti-surge system controlled by gas compressor units with gas turbine drive and duration of the transient process differ essentially from the transient process in the system for the case when there is suboptimal control action at the input of controlled object.

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Семенов Г.Н., Фешанич Л.І., Петеш М.О.
СТАТИСТИЧНА ОЦІНКА АКУСТИЧНИХ СИГНАЛІВ, ЯКІ
ХАРАКТЕРИЗУЮТЬ ПЕРЕДПОМПАЖНИЙ СТАН ВІДЦЕНТРОВОГО
НАГНІТАЧА

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Sementsov G.N., Feshanych L.I., Petesh M.O.
STATISTICAL EVALUATION OF ACOUSTIC SIGNALS WHICH
CHARACTERIZE THE CONDITION OF CENTRIFUGAL BLOWER
BEFORE SURGE

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Анотація. У даній статті проаналізовано складові звукового інформаційного сигналу працюючого газоперекачувального агрегату дотискувальної компресорної станції підземного сховища газу, проведений статистичний аналіз акустичного сигналу та визначено такі характеристики як гістограма, емпірична та теоретична щільність розподілу, закон розподілу, емпірична та теоретична функції розподілу.

Ключові слова: акустичний сигнал, статистична оцінка, відцентровий нагнітач, помпаж.

Abstract. This paper analyzes the components of sound information signal of working gas compressor units of booster compressor stations of underground gas storage facility, statistical analysis of the acoustic signal was conducted and such characteristics as histogram, empirical and theoretical density, distribution law, the empirical and theoretical distribution function were defined.

Keywords: acoustic signal, statistical evaluation, centrifugal supercharger, surge.

Today Ukraine's gas transportation system transports the gas to consumers within the country and to the European countries, so it is relevant and important task to ensure reliability of gas transportation system. There are audio signals up to 200 Pa (140 dB) and higher during operation of gas compressor units (GCU). These sound pressure levels lead to malfunction of measuring equipment and it can indicate possible damage of GCU, because before surge and surge accidents in GCU are accompanied by an increase in sound pressure. This highlights the important task of monitoring the sound pressure levels to take into account the harmful effects of acoustic noise of GCU and diagnosing the condition before surge [1].

However, the analysis of literature [1-3] indicates insufficient studies on the use of acoustic characteristics to improve the existing systems of surge protection and regulation.

The purpose of this paper is to analyze the components of the sound characteristics of the working GCU of booster compressor station (BCS) of underground gas storage (UGS) using statistical methods.

The tests were conducted using gas compressor unit GCU № 9 BCS UGS "Bilche-Volitsa" using acoustic sensor SITRANS AS 100 manufactured by SIEMENS [1].

The measuring channel provides processing the information signal that is the additive sum of measuring signal and noise (Fig. 1). However, the main source of information for solving the problem of control is the noise in GCU that accompany the surge phenomenon.

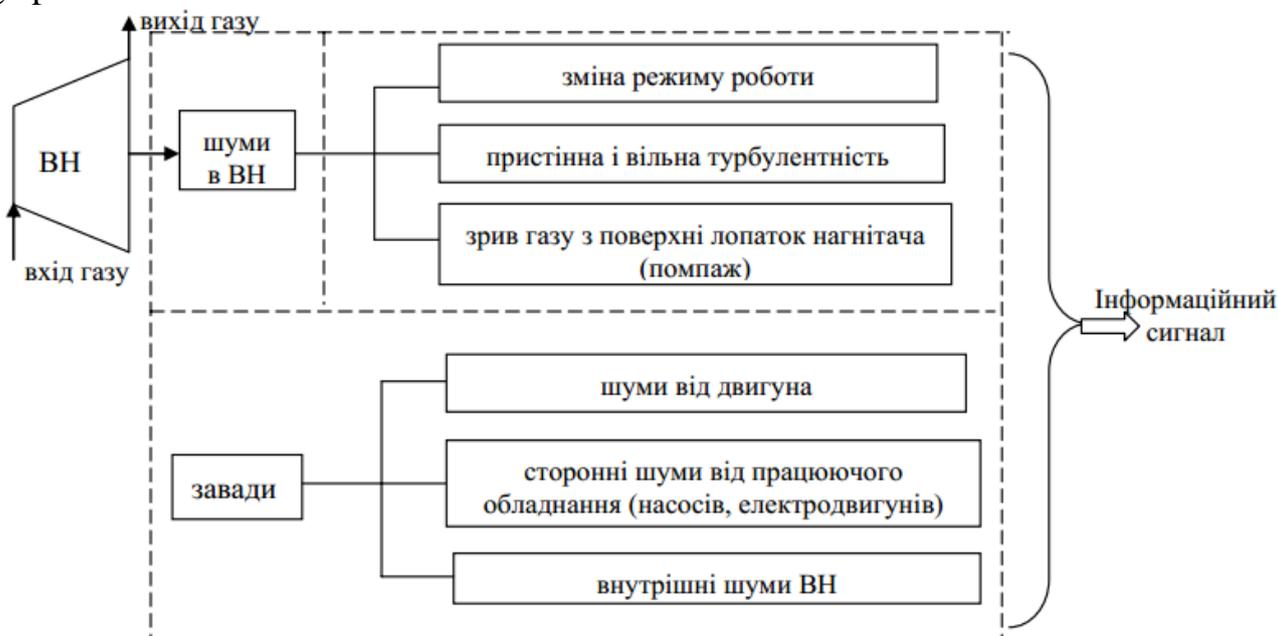


Fig. 1. The components of the acoustic information signal of GCU

Вхід газу - gas inlet

Вихід газу – gas outlet

Завади – noises

Шуми в ВН – noises in VN

Зміна режиму роботи - operational changes

Пристінна і вільна турбулентність - wall and free turbulence

Зрив газу з поверхні лопаток нагнітача (помпаж) – stall of the gas from the surface of blades of the blower (surge)

Шуми від двигуна - motor noises

Сторонні шуми від працюючого обладнання (насосів, електродвигунів) - background noises from operating equipment (pumps, electric motors)

Внутрішні шуми ВН - internal noises of VN

Інформаційний сигнал - information signal

The characteristic sound graphs of the operating GPA during the surge are shown in Figure 2 [1].

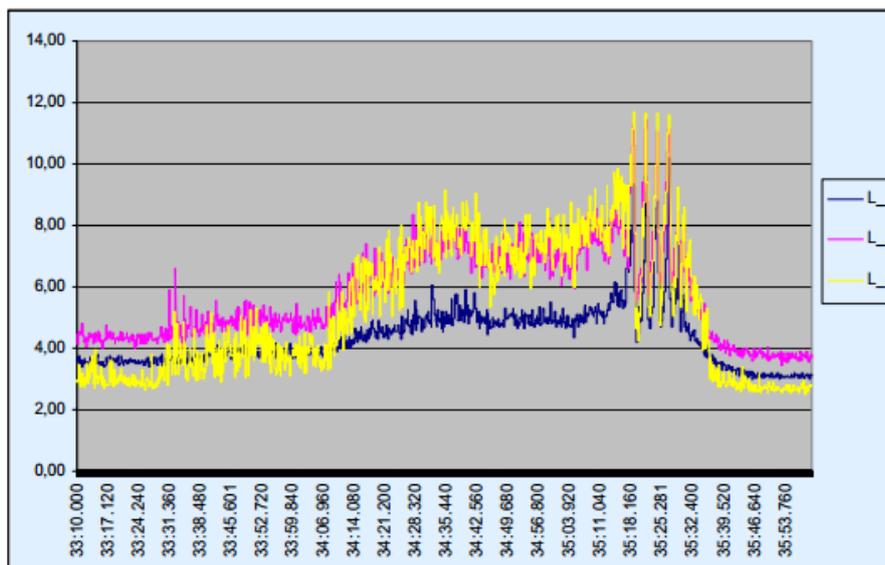


Fig.2. The graphs of sound change in time at the inlet of GCU (L1), on pipe body of GCU (L2) and at the outlet of GCU (L3) from working GCU № 9 BCS UGS "Bilche-Volitsa"

We should analyze the graph of sound change in time at the inlet of GCU (L1) (Fig. 3), which is obtained by using software for digitization Graph2Digit.

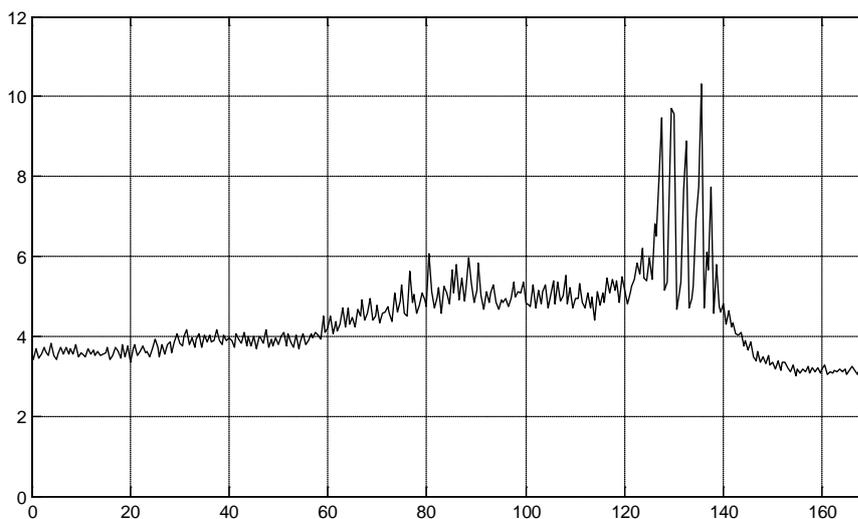


Fig. 3. The graph of sound change in time at the inlet of GCU

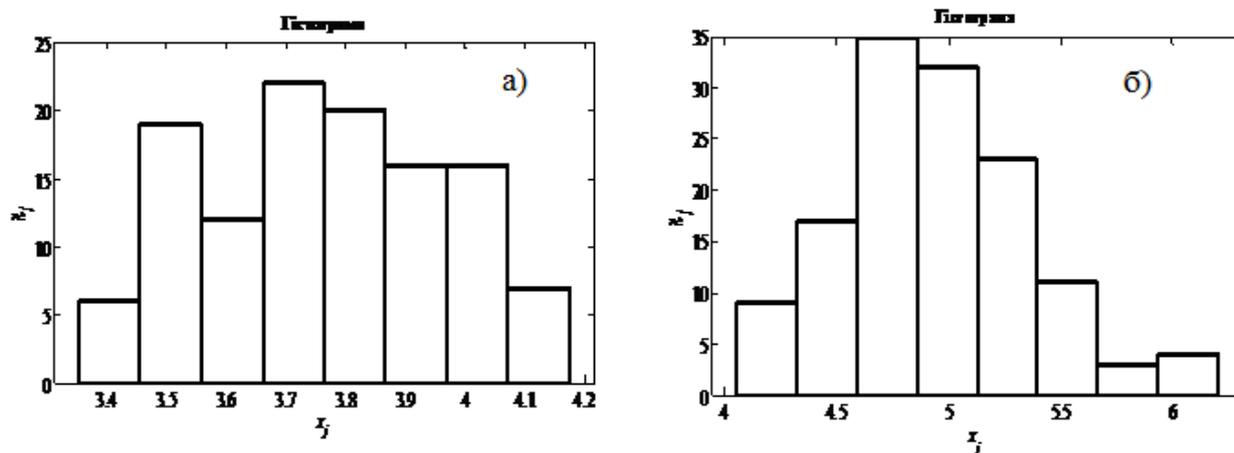
Let us divide the sound graph into two steady intervals: the first interval 0 - 60, the second interval 60-130, so we can define using the software package MathCad their statistical characteristics such as arithmetic mean, geometric mean, variance, mean deviation and others.

Table 1

The statistical parameters of the sample data for sound change in time at the inlet of GCU

	Statistical parameter	Formula	Values	
			Interval 1	Interval 2
	Sample range	$R = x_{max} - x_{min}$	0.821	2.152
	Arithmetic mean	$x_{mean} = \frac{1}{n} \sum_{j=1}^n X_j$	3.767	4.957
	Geometric mean	$g_{mean} = \sqrt[n]{\prod_{i=1}^n X_j}$	3.761	4.939
	Harmonic mean	$h_{mean} = \left(\frac{1}{n} \sum_{j=1}^n \frac{1}{X_j} \right)^{-1}$	3.756	4.922
	Variance: - biased estimate; - unbiased estimate.	$\frac{1}{n} \sum_{s=1}^n (X_j - x_{mean})^2$ $\frac{1}{n-1} \sum_{s=1}^n (X_j - x_{mean})^2$	0.04 0.04	0.174 0.174
	Mean-square deviation: - biased estimate; - unbiased estimate.	$stdev(X)$ $Stdev(X)$	0.199 0.2	0.418 0.419
	Median	$median(X)$	3.76	4.921
	Mode	$mode(X)$	3.55	4.845
	Kurtosis	$kurt(X)$	-0.91	0.302
	Skewness	$skew(X)$	0.08	0.374
0				
1	Number of intervals according to the Sturges' formula	$k = 1 + 3.322 \log(n)$	8.129	7.644
2	Interval width	$h = \frac{R}{k}$	0.102	0.269

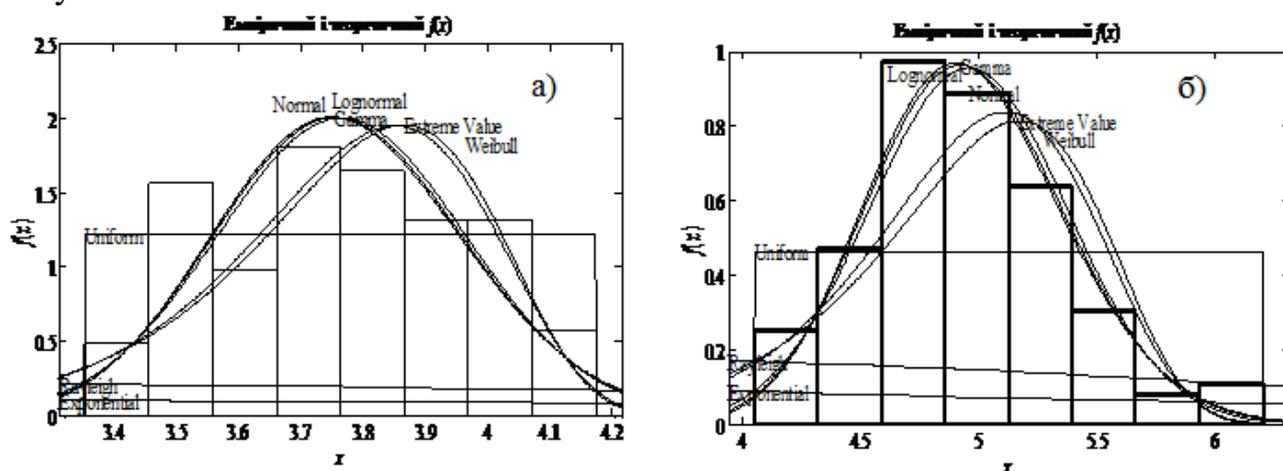
Let us create the histograms of distribution for each of the intervals using the software package MatLab (Fig. 4).



a) – interval 1; b) – interval 2.

Fig. 4. The histograms of distribution of sound change in time at the inlet of GCU

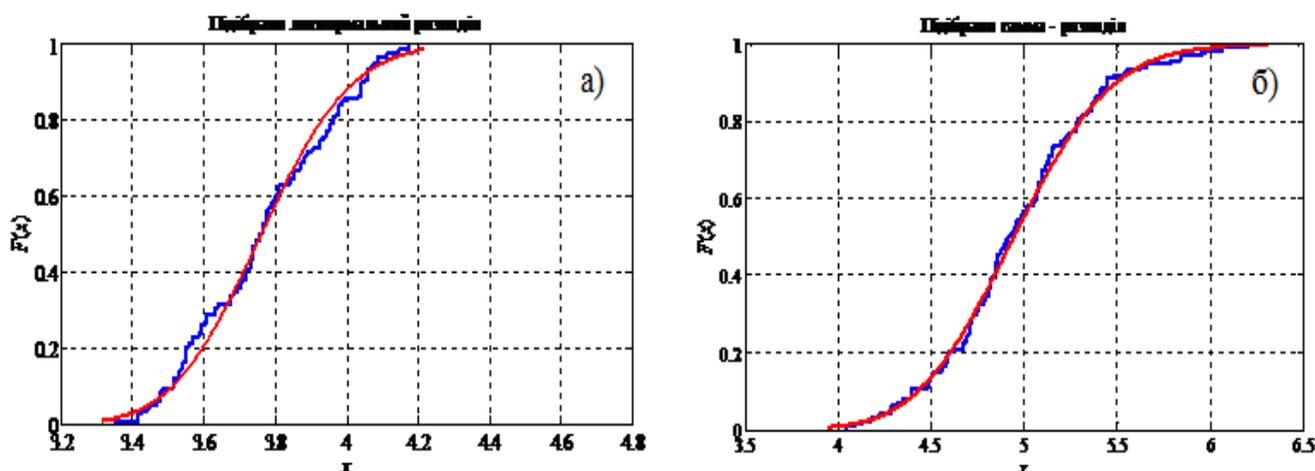
To select the theoretical distribution law we should compare the obtained histograms with graphs of distribution laws. Let us construct empirical and theoretical frequency distribution in order to choose the distribution law most accurately.



a) – interval 1; b) – interval 2.

Fig. 5. Empirical and theoretical frequency distribution of sound change in time at the inlet of GCU

In accordance with the Kolmogorov’s goodness-of-fit test, which uses the maximum difference in modulus between the theoretical and empirical distribution functions, the lognormal distribution is best suited for interval 1 and gamma distribution for interval 2, critical significance levels are 0.44 and 0.93 respectively (Fig. 6).



a) – interval 1; b) – interval 2.

Fig. 6. Empirical and theoretical distribution function of sound change in time at the inlet of GCU

The study found that steady intervals 1 and 2 of graphs of sound change in time at the inlet of GCU correspond respectively to the lognormal and gamma distributions.

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